STORMWATER AND RIVERBANK ASSESSMENT AND SAMPLING PLAN REVISION 2

REMEDIAL DESIGN SERVICES
SWAN ISLAND BASIN PROJECT AREA
CERCLA DOCKET NO. 10-2021-001

PORTLAND HARBOR SUPERFUND SITE
PORTLAND, MULTNOMAH COUNTY, OREGON

Prepared for:

Swan Island Basin Remedial Design Group

Prepared by:

HGL HydroGeoLogic, Inc

11107 Sunset Hills Road, Suite 400
Reston, Virginia 20190

With assistance from:

PACIFIC groundwater GROUP   MOTT MACDONALD   BRIDGEWATER GROUP

December 2021

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Stormwater and Riverbank Assessment and Sampling Plan
Swan Island Basin Project Area
Portland Harbor Superfund Site

Record of Changes / Summary of Revisions

Revision No.	Revision Date	Document Name (If other than entire document, list revised sections or pages)
0	September 27, 2021	Draft Stormwater and Riverbank Assessment and Sampling Plan for EPA review
1	November 11, 2021	Revisions per EPA October 22, 2021, comments
2	December 13, 2021	Revisions per EPA November 19, 2021, comments

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
AECOM	AECOM Technical Services
ASTM	American Society of Testing and Materials
BANCS	Bank Assessment for Non-Point Source Consequences of Sediment
BEHI	Bank Erosion Hazard Index
BEHP	bis(2-ethylhexyl)phthalate
BODR	Basis of Design Report
Bridgewater	Bridgewater Group
city	City of Portland
COC	contaminant of concern
CUL	cleanup level
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDx	DDD+DDE+DDT
EC	electrocoagulation
ECSI	Environmental Cleanup Site Information
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
FSP	Field Sampling Plan
ft	feet
GPS	global positioning system
HASP	Health and Safety Plan
HGL	HydroGeoLogic, Inc.
HVS	high-volume, time-weighted sampling
HxCDF	1,2,3,4,6,7,8-hexachlorodibenzofuran
JSCS	Joint Source Control Strategy
L	liter
L/min	liter per minute
MBDC	Morrison Bridge Datum Correction
mg/L	milligram per liter

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

OCP	organochlorine pesticide
ODEQ	Oregon Department of Environmental Quality
OFS	overflow sampling
OHWM	ordinary high water mark
OU	Operable Unit
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
PeCDD	1,2,3,7,8-Pentachlorodibenzo-p-dioxin
PeCDF	2,3,4,7,8-Pentachlorodibenzofuran
pg	picogram
pg/mg	picogram per milligram
PHSS	Portland Harbor Superfund Site
port	Port of Portland
PTW	principal threat waste
PUF	polyurethane foam
QAPP	Quality Assurance Project Plan
RAL	Remedial Action Level
RD	Remedial Design
ROD	Record of Decision
SAR	Sufficiency Assessment Report
SCM	source control measure
SIB	Swan Island Basin
SMA	Sediment Management Area
SOP	standard operating procedure
SRASP	Stormwater and Riverbank Assessment and Sampling Plan
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDDeq	TCDD Toxic Equivalency
TCDF	2,3,7,8-tetrachlorodibenzofuran
TSS	total suspended solids
UFP	Uniform Federal Policy
USCS	Unified Soil Classification System

STORMWATER AND RIVERBANK
ASSESSMENT AND SAMPLING PLAN
SWAN ISLAND BASIN PROJECT AREA
PORTLAND HARBOR SUPERFUND SITE
PORTLAND, MULTNOMAH COUNTY, OREGON

1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) developed this *Stormwater and Riverbank Assessment and Sampling Plan* (SRASP) for the Swan Island Basin (SIB) portion of the Portland Harbor Superfund Site (PHSS). This plan describes the approach to field data collection that will characterize stormwater and riverbank conditions to support the evaluation of post-remedy recontamination of SIB sediments. The stormwater characterization will include physical inspection of municipal and private stormwater conveyance systems to verify proposed sampling locations and sampling of stormwater and solids. This sampling will provide the data necessary to evaluate stormwater loading and recontamination potential using the SEDCAM recontamination model. The riverbank assessment will be a survey of the riverbanks located along the perimeter of the SIB Project Area displayed on Figure 1-1. The riverbank assessment visual survey will document the physical condition of the riverbanks, identify locations where riverbank soil sampling is feasible, and collect data necessary to inform the use of the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model to evaluate the erodibility of the riverbanks. HGL conducted a site reconnaissance on September 23, 2021, to inform the development and planning of this SRASP.

The SRASP is an abbreviated planning document that is designed to expedite U.S. Environmental Protection Agency (EPA) review and approval of targeted field data collection efforts to begin in December 2021. The proposed work would be a component of the *Draft Pre-Design Investigation (PDI) Work Plan* that is currently in review and development (HGL, 2021a). This SRASP provides a means to accelerate EPA review and approval of seasonally dependent fieldwork so that work may begin in December 2021 while allowing sufficient time to finalize the PDI Work Plan. Only the information that is specifically relevant to the assessment and sampling of stormwater and riverbanks is summarized below. Field staff will review the Field Sampling Plan (FSP) in the PDI Work Plan (HGL, 2021a) to determine the procedures for general tasks such as field documentation, decontamination, and data management. The remaining fieldwork will be performed after EPA approves the final version of the PDI Work Plan.

1.1 SUPPORTING PLANNING DOCUMENTS

The SRASP is supported by the PDI Work Plan (HGL, 2021a). The PDI Work Plan provides background information on the project, identifies the data gaps to be filled, and summarizes the data and information gathering tasks that will be conducted during the PDI to fill these data gaps. A brief description of each PDI Work Plan appendix that supports this SRASP is provided below.

- FSP, Appendix A of the PDI Work Plan: The FSP supports the PDI sampling within the SIB Project Area and the SIB Upland Area and provides details for field sampling locations and procedures for the planned PDI project tasks. The FSP also addresses the field data collection needs identified in the Sufficiency Assessment Report (SAR) to inform the evaluation of potential recontamination.

- *Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP)*, Appendix B of the PDI Work Plan: The UFP-QAPP provides quality control elements to satisfy the data quality objectives for each task specified in the PDI Work Plan. The protocols established in the UFP-QAPP are necessary to ensure that the data generated is of a sufficient quality to support development of valid conclusions.
- *Health and Safety Plan (HASP)*, Appendix C of the PDI Work Plan: The HASP identifies and describes physical, chemical, and biological hazards relevant to each planned field task, and it provides hazard mitigation techniques to address these hazards.
- *Emergency Response Plan (ERP)*, Appendix D of the PDI Work Plan: The ERP will be used in the event of an accident or emergency during performance of the Remedial Design (RD) work.

Upon receiving EPA approval of this SRASP, the finalized text from Section 4.0 (Field and Sampling Activities) will be incorporated into the final version of the PDI Work Plan, which is planned for submittal in late Fall 2021.

1.2 PURPOSE AND OBJECTIVES

This SRASP describes the sampling methodologies and strategies that will be employed to achieve the objectives outlined in the PDI Work Plan. The five principal data gap objectives of the PDI are summarized below and detailed in Section 2.0.

1. Define the specific data and analysis needs required to fully inform the design development and evaluation based on a conceptual design approach and strategy consistent with the Record of Decision (ROD).
2. Compile and evaluate existing available data and analysis relevant to the defined data and analysis needs as determined by the design requirements.
3. Identify data gaps by comparing what is needed to what is available.
4. Develop a work plan to guide the collection of new data and the completion of new analyses to address the data gaps.
5. Ensure that the analysis needs are sufficient to support the Administrative Settlement Agreement and Order on Consent applications required for Sediment Management Area (SMA) refinement, conceptual site model refinement, and effective use of the technology application decision tree (Figure 1-2). As such, PDI surface sediment sampling will be completed to refine the lateral extent of contaminants of concern (COCs).

In this SRASP, SMAs are defined by the horizontal and vertical extent of contamination exceeding PHSS ROD Table 21 remedial action levels (RALs) and/or principal threat waste (PTW) thresholds (Figure 1-2) (EPA, 2017).

2.0 DATA GAP ANALYSIS

The data gap analysis was completed as part of preparing the PDI Work Plan using the following approach:

1. Identify the data and analysis needed, based on the conceptual design approach and strategy, to inform the development and evaluation of an RD for a sustainable and effective remedy;
2. Compile and evaluate data and analysis against specified data and analysis needs; and
3. Identify data and analysis gaps based on the comparison of what is needed to what is available.

The stormwater discharge and riverbank characterization data gap analyses are detailed below and summarized in Table 2-1. The component of the riverbank data gap analysis pertaining to riverbank soil chemistry will be completed after the first phase riverbank assessment survey is completed. That analysis will support preparation of a riverbank soil sampling plan to be conducted as a second phase of the overall riverbank characterization.

2.1 STORMWATER DISCHARGE

There are 5 City of Portland (city), 7 Port of Portland (port), and approximately 44 private stormwater outfalls that discharge to the SIB Project Area from the surrounding upland areas. The upland drainage areas and outfalls that discharge to the SIB are illustrated on Figure 2-1. The status of discharges from some of the private outfalls is unknown and will need to be evaluated as part of the PDI to provide information necessary to complete the SAR (HGL, 2021b). The ROD Table 17 COCs, including SIB recontamination potential chemicals,[1] were detected in stormwater and stormwater solids in public and in a subset of the private outfall basins at concentrations that exceeded the surface water and/or sediment cleanup levels (CULs) and/or RALs. In addition, dioxins/furans have not been adequately characterized either within the public stormwater conveyance systems or at the many private sites in the upland area around the SIB Project Area that are contributing runoff to the SIB Project Area.

For the reasons above, the collection of additional source control data within city outfall basins M-1, M-2, M-3, S-1, and S-2, and select active, private outfall basins is necessary to determine source control sufficiency to complete the SAR and for modeling to assess recontamination potential for the SIB (HGL, 2021b). The rationale for selection of private outfalls is detailed in Section 3.1. The specific data collection and analysis approach to evaluate inputs from upland sites as well as current concentrations of ROD Table 17 COCs in stormwater for the outfalls is provided in Section 3.1. Completion of the ongoing source control and investigation activities at upland properties continues to be within the jurisdiction of the Oregon Department of Environmental Quality (ODEQ) with coordination and input from EPA on upland contamination that may impact

[1] SIB recontamination potential contaminants are PCBs; dioxins/furans (TCDDeq, HxCDF, PeCDD, PeCDF, TCDD, TCDF); pesticides (dieldrin, DDx, total chlordane); metals (arsenic, mercury); diesel-range petroleum hydrocarbons; and bis(2-ethylhexyl)phthalate (BEHP).

the Willamette River. Source control authority has been transferred to EPA for select sites, including the U.S. Coast Guard Facility and the U.S. Navy and Marine Reserve Center.

2.2 RIVERBANK CONDITIONS

The ROD defines riverbanks as areas from the top of the bank down to the river (mean lower low water). Figure 4 in the *Guidance for River Bank Characterizations and Evaluations at the Portland Harbor Superfund Site* (EPA, 2019) presents a flowchart outlining the riverbank evaluation and sampling process for PHSS. It outlines the site-specific riverbank sampling and evaluation process for SIB ROD riverbanks and ROD riverbanks pending characterization. EPA has assumed oversight of the riverbank erosion pathway from ODEQ. The ROD (EPA, 2017) identified three sections of riverbank within the SIB Project Area as areas with known contamination. The locations of those riverbanks are shown on Figure 2-2. A description of each follows:

- One riverbank along the Portland Shipyard property on Swan Island adjacent to the SIB Project Area (1,487 lineal feet [ft] of bulkheads, a historical wooden retaining wall, and/or riprap below ordinary high water mark (OHWM) and vegetated soil above OHWM) (Environmental Cleanup Site Information [ECSI] 271);
- The riverbank along the Portland Shipyard property's Dry Dock Basin and Ballast Water Treatment Plant on the end of the Swan Island peninsula (224 lineal ft of engineered bank consisting of riprap below OHWM and vegetated soil above OHWM); and
- One 911-foot-long riverbank, armored with riprap below OHWM and vegetated soil above OHWM, along the U.S. Navy and Marine Reserve Center (ECSI 5109) in the Mocks Bottom portion of the SIB Upland Area.

Two non-ROD riverbanks were identified based on ROD CUL exceedances in soil during previous investigations: A 713-foot-long unarmored sand riverbank was identified at the head of the SIB, and a 587-foot-long armored bank was identified along the port's N. Lagoon Avenue property adjacent to the SIB (Figure 2-2).

The SAR assigned an initial source control sufficiency status of "uncontrolled" to all shoreline properties because (1) few riverbanks adjacent to the SIB Project Area have been adequately characterized (SAR Figure 6-1 [HGL, 2021b]); (2) there is a potential need for remedial action on shorelines where COCs are present in soils; and (3) contaminated riverbanks are at risk of erosion and could be uncontrolled sources of recontamination. If an in-river sediment SMA does not extend to the toe of the riverbank in portions of the SIB shoreline (i.e., is not contiguous with the riverbank) and the riverbank materials are not erodible, the source control sufficiency status may be downgraded for the riverbank erosion pathway in those areas as further discussed in Section 3.2 of this SRASP. Regardless of source control sufficiency status assigned to a particular riverbank, EPA guidance for riverbanks (EPA, 2019) requires that the entire lateral extent of COCs in the riverbank be characterized.

Data was not available to characterize riverbank stability and the presence of COCs in riverbank soil sufficiently to determine their source control sufficiency status, identify riverbank locations that would need to be addressed as part of the RD, or inform design development for riverbank remediation where required. Section 3.2 of this SRASP describes the objectives of the proposed field survey and data to be collected to address riverbank data gaps.

Pursuant to ROD Section 14.2.9.5, contaminated riverbanks will be remediated through this cleanup where they are contiguous with in-river contamination or where they pose a risk of recontamination to the Selected Remedy (EPA 2017).

The RD will include measures to remediate (i.e., stabilize via capping and/or excavation) the three riverbanks and any other riverbanks within the SIB Project Area identified as needing remedial action. These riverbanks will be determined based on the combined results of the first and second phases of the riverbank evaluation in accordance with the criteria specified in the ROD. The selected remedy for riverbanks will minimize erosion and transport of riverbank materials contaminated above CULs, thereby minimizing recontamination potential via this pathway. Alteration of any riverbank will be discussed and coordinated with shoreline property owners during the RD.

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3.0 PRE-DESIGN INVESTIGATION APPROACH

The data gap analysis (Section 2.0) identified data gaps to be filled during the PDI. Table 2-1 identified stormwater data gaps related to ROD Table 17 COC loading rates from public and private outfalls discharging to the SIB. Those data are needed to (1) determine source control sufficiency to complete the SAR and (2) support modeling analysis to assess recontamination potential related to the stormwater pathway. Section 2.2 identified data gaps related to the physical conditions of the riverbanks, riverbank stability/susceptibility to erosion, and the presence and concentrations of COCs in riverbank soil. Those data are needed to (1) determine the source control sufficiency status of riverbanks (as potential sources of recontamination), (2) identify riverbank locations that need to be addressed as part of the RD, and (3) inform design development for riverbank remediation where required. This data is required to support development of the RD.

In addition to informing RD development, components of the PDI will support completion of the source control sufficiency assessment as documented in the SAR (HGL, 2021b), refinement of SMA delineations, refinement of the conceptual site model, and application of the Technology Application Decision Tree (Figure 1-2) to determine remedial technology assignments. Data gaps are summarized in Table 2-1 along with the proposed data collection and analysis recommended to address those gaps. Data gaps will be addressed using a combination of field data collection (e.g., sampling and surveying) and engineering analysis. This section describes the approach to both the field sampling efforts and engineering studies for the stormwater and riverbank pathways.

3.1 STORMWATER OUTFALL AND CONVEYANCE SYSTEM SAMPLING

This task includes the collection of stormwater and stormwater solids samples within municipal and private conveyance systems that drain to the SIB Project Area. Proposed sampling of municipal conveyance systems will include the city M-1, M-2, M-3 S-1, and S-2 outfall basin conveyance systems and six private conveyance systems. Sampling near the municipal outfalls (but above the river stage and groundwater elevation) is necessary to determine current ROD Table 17 COC concentrations and loads to the SIB. Some ROD Table 17 COCs in stormwater and stormwater solids were detected in city outfall basins at concentrations exceeding surface water and sediment CULs and/or RALs.[2] As further described in Section 6.1 of the SAR (HGL, 2021b), evaluation of available data indicates that additional sampling within city and private outfall basins is warranted for the following reasons:

- Data for stormwater solids collected before some source control measures (SCMs) were implemented in the city's outfall basins indicates that concentrations of polychlorinated biphenyls (PCB) exceeded the CUL in all SIB city outfall basins and the PCB RAL in some locations.
- While pre-SCM data for stormwater and stormwater solids is available for all SIB city outfall basins, no recent post-SCM data is available to determine whether these solids could recontaminate future remedial caps, enhanced natural recovery areas, or monitored natural recovery areas.

[2] Sampling in city outfall basins occurred at various times between 2004 and 2017 relative to the implementation of SCMs or additional stormwater best management practices in each basin.

- Recent sampling of stormwater and stormwater solids indicates COC concentrations in city and private systems at levels that, although similar to other PHSS heavy industrial sites, still exceed the applicable surface water and riverbank/sediment CULs.
- Stormwater or solids sampling data are not available for private outfalls adjacent to areas that have had Tables 17 and 21 COC concentration exceedances in surface sediment.

In addition, dioxins and furans are present in surface sediment in the vicinity of the city and private outfalls. However, dioxins/furans have not been adequately characterized either within the stormwater conveyance systems or at the many sites in the SIB Upland Area that are contributing stormwater to these conveyance systems or directly discharging into the SIB Project Area.

This SRASP includes a task to identify and address other data gaps for stormwater outfalls. Data will be used to evaluate the effects of stormwater with ROD CUL or RAL exceedances within the SIB project area. Figure 3-1 shows the proposed stormwater sample locations within the city M-1, M-2, M-3, S-1, and S-2 outfall basins. Table 3-1 summarizes invert elevations of proposed sampling locations in the city's system as well as possible alternative sample locations representative of basin discharges, if access constraints or possible backflow are identified.

Most SIB outfalls are submerged at least part of the year, causing flow reversals within the pipe that would confound stormwater loading evaluations. Therefore, manhole locations that have pipe invert elevations above the highest estimated wet season water elevations and that are closest to the target outfalls were selected as the representative "End of Pipe" sample locations for proposed high-volume, time-weighted sampling (HVS) (i.e., manholes AAM107, AAM169, AAQ004, AAP957, and AAM131).[3] Table 3-1 identifies alternate HVS locations to use if the primary manholes are flooded because of a high tide or storm event and cannot be sampled (i.e., the SIB river stage elevation [as measured via a water level probe installed in the SIB and corrected to Morrison Bridge Datum Correction (MBDC)] is predicted to be higher than a pipe invert elevation). Comparisons of pipe invert elevations to river elevations will be completed before mobilizing to the field so that the necessary preparations (e.g., traffic control, access notifications) can be completed in advance.

The HVS sampling methodology, which will be followed using a Gravity Marine PR2900 system, is a time-weighted sampling method that emphasizes collecting samples during the highest flow periods of a sampling event. The HVS method will target collecting samples during storms that occur when the river stage is below the manhole elevation. This approach is expected to ensure that samples are representative of stormwater discharges and are not influenced by river water backing up into the pipe.

HVS at these key locations will include the collection of time-weighted stormwater, stormwater solids, and level-velocity flow data during three representative storm events over an approximately

[3] High-volume water samples are collected to quantify concentrations of targeted organic chemicals (e.g., dioxins/furans, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods. This method also allows for quantification of hydrophobic organic chemicals in the suspended particle and dissolved phases of the water column. EPA approved the HVS equipment system, the Gravity Marine PR2900, for use on the PHSS PDI and baseline sampling surface water sampling event (AECOM and Geosyntec, 2019). This sampling methodology is a form of time-weighted sampling.

9-month period and to add the data to the SEDCAM recontamination model to predict future total COC loading to the SIB Project Area. In addition, level-velocity loggers and in-line sediment traps will be installed in sub-basin laterals to the manholes to collect continuous data that will be composited into two separate sampling periods (wet season from December 2021 through June 2022 and dry season from July through October 2022) for comparison to the data collected during the three individual HVS storm events. The dry season deployment may be terminated early if wet weather before the end of October is predicted. Prior to deployment, HGL will confirm that manhole sampling will occur when river elevations are sufficiently below manhole sump elevations.

This SRASP also includes the collection of manual grab samples of stormwater solids at the same locations as the in-line sediment traps (prior to deployment) and possibly at manholes further up-pipe within the city conveyance system. The manual grab samples and the in-line sediment trap samples will be independent samples that will not be composited. The rationale for collecting manual grab samples from laterals in sub-basins of each city outfall basin, prior to sediment trap deployment, is collect any materials present in the line in the unlikely event that no solids are collected in the sediment traps. These solids will be archived (frozen) for potential future analyses. Data from either the sediment traps or the grab samples will be added to the SEDCAM recontamination model to inform the relative Table 17 ROD COC load from each major sub-basin (i.e., each sub-basin of the outfall basins in the city conveyance system). The data will identify potential ongoing sources of contamination by evaluating stormwater solids data collected downstream of upland industrial sites. Refer to Appendix A of the SAR for more detail on the SEDCAM modeling approach, specifically regarding how stormwater data will be used to calculate mass loading of COCs into the SIB.

The sampling locations proposed for in-line and grab stormwater solids are shown on Figure 3-1 and are listed in Table 3-1. These locations are as follows:

- The main line into manhole AAM107 from all sub-basins in the city M-1 outfall basin (map identification is OFM-1);[4]
- Three laterals into manhole AAM169 from sub-basins in the city M-2 outfall basin (map identification is OFM-2);
- Two laterals into manhole AAQ004 within the city M-3 outfall basin (map identification is OFM-3);[5]
- Two laterals entering manhole AAM131 within the city S-1 outfall basin (map identification is overflow sampling [OFS]-1); and

[4] In-line sediment trap deployment and manual collection of solids samples are not proposed at this location due to past and likely future river backflow. If field reconnaissance conducted during high tide indicates that a sediment trap can be installed above the highest river elevation, then a sediment trap will be installed at this location, with the inlet above the highest river elevation. The proposed HVS monitoring and solids sampling location may be moved to AAM104, where river backflow is less likely (i.e., pipe invert elevation of 13.01 ft MBDC versus 6.58 ft MBDC at AAM107).

[5] Manhole AAQ004 is proposed instead of manhole AAQ003 because the pipe invert elevation in AAQ003 is below the river elevation range for the wet season (3.33 ft MBDC versus 4 ft to 10 ft MBDC).

- Two laterals entering manhole AAP957 within the city S-2 outfall basin (map identification is OFS-2).

In addition to city conveyance system monitoring, private systems will be instrumented with Teledyne ISCO autosamplers and flow sensors after access has been granted and site inspections have been performed to collect time-weighted composites samples during qualifying ODEQ and EPA Joint Source Control Strategy (JSCS) guidance storm events to assess the need for upland source control (Figure 3-1) (ODEQ and EPA 2005). The private stormwater systems with direct discharges to the SIB that will be sampled and the rationale for sampling them are as follows:

- The U.S. Coast Guard Marine Safety Unit (historical pre-SCM CUL exceedances in stormwater and stormwater solids and adjacent to RAL and PTW threshold exceedances in sediment) (WR-201 or WR-198 sub-basin);
- PATC Leasing (historical CUL exceedances in stormwater and adjacent to RAL exceedances in sediment) (WR-68, WR-71, or WR-289 sub-basin);
- Barge Eagle Inc./Swan Island Dock Company (historical CUL exceedances in stormwater and adjacent to CUL exceedances in sediment) (WR-68, WR-185, or WR-186 sub-basin);
- North Basin Watumull LLC/Swan Island Dock Company (no stormwater or stormwater solids data available, historical pesticide releases, and adjacent to RAL exceedances in sediment) (WR-15 sub-basin);
- Daimler Trucks North America Corp 5 Wind Tunnel property (no stormwater or solids data available and adjacent to RAL exceedances in sediment) (WR-253 sub-basin); and
- Port property on N. Lagoon Avenue, the former Swan Island Upland Facility Operable Unit (OU) 3 (historical pre-SCM CUL exceedances in stormwater and stormwater solids, discharges to ROD riverbank, and adjacent to RAL exceedances in sediment) (one of the WR-30 through WR-35 sub-basins).

Sampling locations at the six private facilities listed above will be selected after site inspections are performed, and the list of selected locations and the outfalls to which they discharge has been provided to EPA for approval. Once selected, HGL will provide an addendum to the SRASP with information on the selected outfall basins or sampling locations (e.g., in manholes or catch basins) for the private facilities. The rationale for the selected outfall basins will consider the size of the area that drains from the outfall, the operations within the outfall basin, previous stormwater data from the drainage basin (if any), sediment concentrations adjacent to the outfall, and whether the selected outfall basin can be used to represent contaminant concentrations in stormwater from other outfalls at each facility.

While ROD CUL and RAL exceedances are present in surface sediment adjacent to the Portland Shipyard, Vigor Industrial LLC is implementing SCMs under an ODEQ Consent Order and Tier 2 measures under its National Pollutant Discharge Elimination System (NPDES) 1200-Z stormwater permit to control CUL exceedances in its stormwater discharges. Vigor Industrial LLC is also sampling stormwater for dioxin/furans pursuant to the ODEQ Consent Order (Floyd|Snider, 2020c). The Portland Shipyard outfalls that historically discharged to the basin in the SIB Project Area include 2 that were rerouted to a treatment facility in 2017 and 18 that will be rerouted for electrocoagulation (EC) treatment in 2021. Two additional outfalls that discharged to the Portland Shipyard's dry dock area were rerouted for treatment in 2017. Treated effluent from the rerouted outfalls discharges to the main channel of the Willamette River at berth 313 (see Figure 3-1). All of the outfall basins in the shipyard are treated, either through active treatment in the EC system (outfall basins Q, S, S1, E, and F) or through passive treatment, including the outfalls on Pier D and the scuppers on Pier C. The exact types of passive treatment (e.g., double rain barrels, custom catch basin inserts, and Grattix boxes) are described in Vigor's Tier II Corrective Action Report and its Monitoring and Performance Evaluation Reports (Floyd|Snider 2020 and 2020b). Currently, five outfall basins (M1, G, Pier C, Q, and R) discharge treated stormwater to the SIB Project Area. These discharges are monitored as part of NPDES 1200-Z industrial stormwater permit requirements. One outfall basin (M) discharges stormwater to the city's S-1 conveyance system, which will be monitored under the SRASP.

Additional data on the proposed sample locations, sampling methodology, analytical approach, and schedule is provided in the FSP (Appendix A of the PDI Work Plan [HGL, 2021a]) and UFP-QAPP (Appendix B of the PDI Work Plan [HGL, 2021a]).

3.2 RIVERBANK CHARACTERIZATION

Riverbank characterization is needed to fulfill three purposes: (1) address data gaps necessary to complete the source control sufficiency assessment, (2) determine the full extent of contamination exceeding the ROD CULs, and (3) provide data necessary to support RD for remediation of contaminated riverbank soils.

Riverbank characterization will be performed in two phases, with one field mobilization each, to identify and characterize the types of materials present in the riverbanks, locate, and delineate areas of potentially erodible sediments, sample grain sizes (through subsequent laboratory sieve analysis), and locate areas of geotechnical movement (slope rotational failure, settlement). This SRASP addresses only the first phase. The first phase will include an assessment survey of the entire riverbank within the SIB Project Area and completion of a bank stability analysis using the BANCS model, including Bank Erosion Hazard Index (BEHI) and near bank stress determinations. The first phase of the proposed riverbank characterization includes visually inspecting the riverbank and material types to determine input parameters for the BANCS evaluation. After completing this inspection, HGL will prepare a riverbank soil sampling plan as an addendum to this SRASP. The addendum will include the data quality objectives and proposed sampling locations. The first phase assessment survey will be performed when water levels are at their lowest in the SIB (anticipated for Fall 2021 or early 2022). Chemical characterization will be used to meet the ROD objectives; identify the nature of contamination relative to CULs, RALs, and PTW thresholds; and inform the RD when contamination is present (EPA, 2019).

The proposed two-phased characterization will develop data required to determine which riverbank areas need further detailed erodibility/stability assessments by coastal and geotechnical engineers during the PDI. This data will also be used to delineate riverbank areas susceptible to erosion for future use in the RD. Coordinates of erodible and non-erodible areas will be mapped using handheld global positioning system (GPS) units, backed up with field notes on tablets. During the second phase of the riverbank characterization, riverbank soil sampling for chemical characterization will be performed at 126 riverbank transect locations (see Figure 3-2), including a surface soil sample and a subsurface soil sample at each sampling location along the transects (e.g., top, face, and toe of bank). Riverbank soil sampling will be deferred until the proposed first phase riverbank survey has been completed. EPA guidance for riverbanks (EPA 2019) requires that the entire lateral extent of the riverbank be characterized.

The proposed two-phased approach to riverbank characterization includes the following sequential steps:

1. Assemble available topographic and nearshore bathymetric maps and light detection and ranging maps to obtain topographic inputs for the BANCS analysis;
2. Conduct a riverbank assessment survey to characterize existing bank conditions, collect data sufficient to run a BANCS analysis for 126 transect locations to calculate bank erosion indices and near bank stress values, and identify locations where riverbank soil sampling is feasible based on material types;
3. Compile riverbank assessment data and perform a BANCS evaluation to calculate the degree of erodibility of the banks;
4. Identify riverbank soil sampling locations based on the results of the riverbank assessment survey, results of the BANCS evaluation, and review of existing riverbank soil data;
5. Prepare a riverbank soil sampling plan and provide it to EPA for review and approval prior to initiating sampling; and
6. Conduct riverbank soil sampling.

This SRASP includes only the first phase of the riverbank characterization. The first phase includes the Step 1 riverbank assessment survey, the Step 2 data collection to support the BANCS modeling analysis, and the Step 3 data compilation and run of the BANCS model. For the second phase of the work. The specific approach for Steps 4 through 6, conducted during the second phase of the riverbank characterization, will be documented in the Final PDI Work Plan and in the riverbank soil sampling plan addendum, which will be prepared after the riverbank assessment survey and BANCS evaluation steps have been completed.

For riverbank areas with existing data and adjacent to sediment SMAs, the concentrations of ROD COCs at those areas will dictate how they are incorporated into the Basis of Design Report (BODR) as follows:

- If ROD Table 17 COC concentrations are less than the CULs, no action will be necessary.
- If ROD Table 17 COC concentrations are above the CULs, the vertical and lateral extent of the exceedances will be delineated, a BANCS analysis (or equivalent) will be performed, and a lines of evidence approach will be presented to evaluate whether RAO 9 [6]can be achieved by a planned action.

[6] "RAO 9 – River banks: Reduce migration of COCs in river banks to sediment and surface water such that levels are acceptable for human health and ecological exposures" (EPA 2019).

- If ROD Table 21 focused COC concentrations are between the CULs and the RALs, the vertical and lateral extent of the exceedances will be delineated, a BANCS analysis (or equivalent) will be performed, and the RD for the riverbank will be designed to resist erosion (e.g., from stormwater runoff, tidal fluctuations, propeller wash).
- If ROD Table 21 focused COC concentrations exceed the RALs, the vertical and lateral extent of the exceedances will be delineated, a BANCS analysis (or equivalent) will be performed, as noted above, and the RD for the riverbank will be designed in accordance with the requirements of the ROD. Remedial technologies to address contaminated riverbank soils may include bank stabilization to resist erosion (e.g., from stormwater runoff, tidal fluctuations, propeller wash), removal of contaminated soils, and/or capping of contaminated soils.

Characterization data was available for only three shoreline properties in the SIB Upland Area: city property with a public boat ramp at the head of the SIB and two former OUs of the Swan Island Upland Facility (Portland Shipyard [OU1] and Port property on N. Lagoon Avenue [OU3]). Sampling results for these three sites were evaluated in Section 6.0 and Appendix E of the SAR (HGL, 2021b). ROD CULs for riverbank soil and in-water sediment and PCB RAL exceedances were identified. Detected concentrations of metals, PCBs, and polycyclic hydrocarbons exceeded the ROD CULs at the Portland Shipyard, and PCBs exceeded the RAL and PTW threshold. Because the lateral extents of the exceedances were not defined and all ROD COCs were not analyzed, these conditions were identified as data gaps for the PDI, and additional characterization has been proposed.

Remediation of impacted riverbanks with adjacent SMAs will become part of the preferred remedial approach presented in the BODR so that the connections between riverbanks and adjacent sediment remediation are accounted for and addressed in an efficient overall design strategy.

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4.0 FIELD AND SAMPLING ACTIVITIES

The field activities described in this section flow from the data gap evaluation conducted based on the results of previous site investigations. Field activities include stormwater, stormwater solids, and in-line sediment trap sampling as well as riverbank evaluation. Refer to Table 4-1 for a summary of stormwater field activities and associated proposed samples and analyses. Worksheet #23 the QAPP summarizes analytical methods for solids and stormwater.

Field sampling activities will be conducted under the HASP and performed in accordance with the standard operating procedures (SOPs) included in Appendix A. SOPs were selected from previous Portland Harbor FSPs and from SOP libraries maintained by HGL, EPA, Pacific Groundwater Group, Mott Macdonald, and Bridgewater Group (Bridgewater). Standardized forms to be used for recording field data are included in Appendix B. Individual SOPs also include field forms to be used.

Information on chain of custody, packaging, and shipping procedures for samples is in Worksheets #26 and #27 of the UFP-QAPP. Hard copies of these documents will be provided to the project team.

4.1 STORMWATER AND STORMWATER SOLIDS SAMPLING

Current stormwater and stormwater solids concentrations are needed to estimate ongoing ROD Table 17 COC concentrations and loads to the SIB sediments using the SEDCAM recontamination model. Samples will be collected from five city outfall basins (M-1, M-2, M-3, S-1, and S-2) as well as from six private outfall basins that discharge to the SIB shoreline. Equipment will be placed at elevations sufficient to minimize the potential for river water to back up to the sample location and compromise the quality of level-velocity data, the integrity of the sediment traps, and collection of quality stormwater samples.

Techniques for obtaining stormwater samples from city conveyance systems include using an HVS system to collect and process each sample set (Gravity Marine PR2900). The system consists of a high-volume peristaltic pump or submersible pump, depending on the depth of the water in the manholes, and a series of filters to capture the particulate phase and a resin column to capture the dissolved fraction of focused COCs. Stormwater collected via the high-volume pump will be run through an HVS system to separate stormwater and stormwater solids for separate phase (dissolved and particulate) analyses. This method is used to collect samples for analysis of hydrophobic organic compounds (dioxins/furans, PCBs, and pesticides) by ultra-low detection limit analytical methods. Analysis of stormwater samples collected via the HVS method is more likely to detect lower concentrations of focused COCs resulting in method detection limits that are at or below the CULs in ROD Errata #2 Table 17 (EPA, 2020). This method also allows for quantification of hydrophobic organic chemicals in the suspended particle and dissolved phases of the water column. EPA has approved the Gravity Marine PR2900 sampling system for the collection of representative surface water and stormwater samples in the PHSS (AECOM Technical Services [AECOM] and Geosyntec, 2018; and Foth Infrastructure & Environment, LLC, 2021). In addition to the samples collected by the HVS system, physical field measurements and separate whole water samples will be collected using a separate pump and carboy.

Stormwater sampling criteria will be consistent with the criteria in Appendix D of the 2005 ODEQ and EPA JSCS (ODEQ and EPA, 2005):

- An antecedent dry period of at least 24 hours (as defined by less than 0.1 inch of precipitation over the previous 24 hours).
- A minimum predicted rainfall volume of greater than 0.2 inch per event.
- An expected storm duration of at least 3 hours.

The storm will be tracked via the National Weather Service, local media outlets, and the Windy forecast at www.windy.com to estimate the length of the storm event. The Portland Harbor JSCS guidance (ODEQ and EPA, 2005) storm event criteria and selection will be used to ensure that stormwater runoff will be adequate for sample collection.

Because homeless people are present in the city's Swan Island boat ramp parking lot where manhole AAQ-004 is located (i.e., head of the SIB), an outreach strategy and protocol will be included as an appendix to the HASP.

In addition to collecting stormwater solids via the HVS method, stormwater solids will be collected by (1) manual grab sampling from public manhole sumps and adjacent laterals in the conveyance systems prior to installation of sediment traps for possible analyses (if inadequate sample volumes are collected in the sediment traps) and (2) time-integrated, in-line, sediment traps within the public conveyance system.

Because of the smaller size of the private outfall conveyance systems discharging along the SIB shoreline, HGL proposes to equip the conveyance systems to these outfalls with automatic samplers (Teledyne ISCO® 6712C with flow meters) and to collect stormwater and solids samples during rain events that meet the ODEQ-EPA JSCS criteria, as described above. Teledyne ISCO portable automatic samplers will be deployed to collect stormwater samples and level-velocity measurements at elevations unlikely to be affected by backflow of river water during storm events and high tides. Manual grab samples of stormwater solids will also be collected from the private conveyance systems before deployment of the portable samplers.

HGL proposes to monitor portions of the private systems that have the largest drainage basins and that are most likely to carry ROD COCs in direct discharges to the SIB. These systems are associated with the following properties as shown on Figure 3-1: U.S. Coast Guard Marine Safety Unit, ATC Leasing Co., Barge Eagle, Inc./Swan Island Boast Company, North Basin Watumull, DTNA Corp 5 Wind Tunnel, and the port's N. Lagoon Avenue property. The exact sampling locations in the private conveyance systems will be identified after site access agreements have been negotiated and site inspections have been performed, and a list of them will be submitted to EPA for approval prior to equipment deployment and monitoring.

Solids will be visually described following the American Society of Testing and Materials (ASTM) International Standard D2488 (ASTM, 2017) and the Unified Soil Classification System (USCS) visual soil classification procedures.

The types of samples that will be collected at each of the proposed sample locations are shown on Figure 3-1 and in Table 3-1.

4.1.1 HVS Sampling Methodology for City Outfall Basins

Stormwater and stormwater solids will be collected during three representative storm events by pumping large quantities of stormwater from city manholes with a high-volume peristaltic or submersible pump and processing the water through an HVS system. This work is proposed to be conducted by a subcontractor (Gravity Marine) with HGL oversight. High-volume water samples will be collected to quantify concentrations of targeted organic chemicals (e.g., dioxins/furans, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods. This method also allows for quantification of hydrophobic organic chemicals in the suspended particle and dissolved phases of the water column. Stormwater and stormwater solids collection will be performed in accordance with SOP A-5, Gravity Marine HVS Sampling (Appendix A).

Stormwater samples to be analyzed for ultra-low concentrations of organic compounds will be collected using a high-volume peristaltic pump (with no screen) with both platinum silicone tubing and extended Teflon™-lined polypropylene sample tubing lowered to the desired depth within the conveyance system. This sampling method is required to achieve the very low Table 17 CULs, which are below standard method reporting limits for PCBs, dioxins/furans, and organochlorine pesticides (OCPs). Water pumped at a rate of up to 1.5 liters per minute (L/min) will be drawn through Teflon™ tubing and through each filter set. The pump rate will be managed to collect a minimum of 200 liters (L) over each storm event, which typically last 4 to 6 hours. The HVS system can be paused if the stormwater flow temporarily subsides due to fluctuating precipitation rates. The rate of water pumped through the HVS will be checked at 15-minute intervals to ensure that water is flowing at a constant rate using a 1-L graduated cylinder and a timer. If the pump is not delivering the correct flow rate, fine adjustments will be made until the optimum flow is achieved. If a submersible pump is required because of the water depth in the manholes, the water will be pumped through Teflon™-coated tubing from the pump (with no screen) to an 8-gallon carboy, possibly going to an intermediate 8-gallon carboy first, and then through the same type of tubing from the carboys to the HVS pump and standard peristaltic pump. The pumps will be turned on/off to maintain the level in the carboys at approximately 80% capacity without overflowing.

Within the HVS system, the stormwater will pass sequentially through a high vortex separator, a 0.45-micron glass fiber filter (142 millimeter), and a polyurethane foam (PUF) cartridge. The high vortex separator can separate suspended sediments by forcing the water in a centrifugal fashion. Solids collected from the vortex separator and 0.45-micron glass fiber filter will be combined, homogenized, and placed into appropriate sample containers for analysis. A list of required sample containers and preservatives can be found in Worksheets #19 and #30 of the UFP-QAPP. The compounds that bind to the adsorbent PUF material will be extracted and measured on a gas chromatograph/mass spectrometer. Samples will be stored in a cooler at 0 to 6 degrees Celsius (°C) and sent to the selected laboratory for analysis.

Physical field measurements and a separate whole water sample will be collected in tandem with the HVS system sampling by connecting a second Teflon™-lined polypropylene tube to a second peristaltic pump, tubing set, and carboy with mixing chamber. This pump will have a flow-through chamber with a YSI Exo multimeter installed for continuous measurement of dissolved oxygen, pH, turbidity, and temperature. A subset of stormwater collected in the carboy will be placed into appropriate sample containers for total suspended solids (TSS) and total organic carbon analysis. Required sample containers can be found in Worksheets #19 and #30 of the UFP-QAPP. Those sample bottles and the full volume of the carboy will then be stored in a cooler at 0 to 6 °C and transported to the selected laboratory for processing and analysis. The whole water sample will be analyzed for ROD Table 17 COCs, except the PCBs, OCPs, and dioxins and furans. If there is a sufficient volume of stormwater solids available in the carboy after the removal of the whole water sample, those solids will be separated by centrifuge in the laboratory and analyzed for ROD Table 17 COCs, except the PCBs, OCPs, and dioxins and furans.

4.1.2 Calculating Dissolved, Particulate, and Total Fractions from HVS Samples

4.1.2.1 Particulate Phase

Stormwater samples will be collected using the PR2900 HVS connected to a vortex solids separation system and a 0.45-micron glass filter. The high vortex separator captures suspended sediments by forcing the water in a centrifugal fashion before exiting toward the 0.45-micron glass filter and then the PUF cartridge. The solids captured in the vortex separation system and the solids on the glass filters will be placed in one sample container, stored in a cooler at 0 to 6 °C, and shipped to the selected laboratory. The combined solids sample will be referred to as the "Front Half" of the HVS system and will be analyzed by the selected laboratory to represent the total particulate-phase fraction of ROD focused COCs collected throughout the storm. The concentration data from the particulate fraction will be used to (1) mathematically calculate the particulate phase portion of the whole water concentration (see Section 4.1.2.1.2) and (2) mathematically calculate the particulate concentration in units of solids for comparison to the ROD sediment CULs (see Section 4.1.2.1.3).

To support the second calculation, TSS will be measured by the selected laboratory from a sample collected from the carboy via a second peristaltic pump (SOP A-5, Gravity Marine HVS Sampling, Appendix A).

4.1.2.1.1 Dissolved Phase

After stormwater has been pumped through the "Front Half" of the HVS system and solids have been removed via the high vortex separator and 0.45-micron glass filter, the water will enter the "Back Half" of the HVS system and be drawn through the PUF cartridge. The cartridge will contain solid-phase extraction resins that bind dissolved forms of the compounds in question (e.g., PCBs). Once the HVS system has been turned off, the sealed PUF cartridges will be labeled and sent to the selected laboratory for analysis of the dissolved fraction of PCB congeners, dioxins/furans, and OCPs in stormwater. These analyses are listed for the aqueous matrix in Worksheets #19 and #30. Collected samples will be placed in laboratory-provided glass jars and stored in a cooler at 0 to 6 °C until transport to the laboratory.

4.1.2.1.2 Whole Water Concentration

One objective of the HVS method will be to quantify the PCB congeners, dioxins/furans, and OCPs concentrations in stormwater at levels that are below, or similar to, the low-level CULs established for surface water in PHSS. This section describes how to convert the mass measurements provided by the laboratory into a whole water concentration that can be compared to ROD surface water CULs.

The laboratory will report the total mass of the particulate (i.e., "Front Half") and dissolved phase (i.e., "Back Half" driver COCs) in laboratory reports in units of picograms (pg). Once that data has been validated, it will be used to mathematically calculate whole water concentrations using the following equation.

$$\frac{\text{Particulate Phase (pg)}}{\text{Sample Volume (L)}} + \frac{\text{Dissolved Phase (pg)}}{\text{Sample Volume (L)}}$$

$$= \text{COC Concentration (picogram per liter [pg/L])}$$

where:

- Particulate phase is the analytical sample consisting of the solids from the vortex and glass microfiber filters (pg/sample);
- Dissolved phase is the dissolved fraction adsorbed to the PUF cartridge (pg/sample); and
- Sample volume is the total amount of water passed through the PR2900 during sample collection (L).

As noted in SOP A-5, Gravity Marine HVS Sampling (Appendix A), a minimum target volume of 200 L of water will be pumped through the system. Flow rates will be low (approximately 1.5 L/min) to allow for adsorption of dissolved-phase COCs to the PUF cartridge and to ensure that equal representation from the storm is reflected in the combined analytical results. Each storm and associated location will have different total volumes pumped. These volumes will be provided by the subcontractor and used by HGL in these calculations.

4.1.2.1.3 Particulate Phase Concentration

A second objective of the HVS method is to capture enough stormwater solids to quantify the concentration and loading rate of those solids discharging from the city outfall basins to the Willamette River and evaluate the risk of ongoing recontamination to sediment near the outfalls. This section describes how the particulate phase mass provided by SGS (in pg) and the TSS measurement provided by ALS Global (in milligrams per liter [mg/L]) will be used to calculate the focused COC concentrations in stormwater solids, which can then be compared to the ROD CULs and RALs in Tables 17 and 21, respectively.

After the laboratory data has been validated, the data will be used to calculate whole water concentrations using the following equation.

$$\frac{\text{Particulate Phase Mass (pg)}}{\text{TSS (mg/L)}} \div \text{Sample Volume (L)}$$

$$= \text{COC Concentration (micrograms per kilogram)}$$

where:

- Particulate phase is the analytical sample consisting of the solids from the vortex and glass microfiber filters (pg/sample);
- Sample volume is the total amount of water passed through the PR2900 during sample collection (L);
- TSS is the concentrations (in mg/L) measured from an aliquot of water collected from the carboy sample; and
- The resultant ROD Table 17 COC concentration is in micrograms per kilogram, which is equivalent to pg/mg.

4.1.3 Automatic Stormwater Sampling Methodology for Private Outfalls

During the three storm events selected for HVS sampling or similar events meeting ODEQ-EPA JSCS criteria (as described above), time-weighted, composite stormwater samples will be collected from six private outfall basin locations using automatic samplers to provide a “snapshot” of ROD Table 17 COC concentrations discharging to the SIB during rain events meeting the ODEQ-EPA JSCS criteria similar to the HVS samples collected in city outfall basins, although during shorter sampling duration events (e.g., 0.5 hour to 3 hours versus 6 to 8 hours for HVS). Time-weighted composite samples will be collected during storm periods expected to have higher chemical concentrations (e.g., rising limb of stormwater flow hydrograph) to increase the likelihood of detecting COCs if discharging in stormwater.

Autosamplers (e.g., Teledyne ISCO® 6712C portable samplers with level-velocity loggers) will be used to collect grab samples from small private conveyance systems to assess whether COCs in stormwater are controlled prior to the RD. The samplers will be automatically programmed to collect storm-event-triggered, flow-weighted composite samples to evaluate ROD Table 17 COC concentrations discharging to the SIB and the need for SCMs. Proposed deployment locations were selected based on the location of discharges relative to SMAs, ROD CUL/RAL exceedances, and/or lack of data adjacent to SMAs.

The autosamplers will be installed at locations that best represent stormwater flow to selected outfalls to the SIB. The autosamplers will be installed either inside a stormwater feature (manhole or catch basin) or adjacent to the feature at ground level depending on location conditions, access, and security. The autosamplers will be connected to a compatible flow sensor that will establish when flow is elevated above baseline conditions and record real-time velocity and volume. The autosampler will have a dedicated 5-gallon whole water sample container from which the sampler will pump representative unfiltered stormwater at a rate and frequency dependent on the measured flow rate and volume (i.e., a storm-event, flow-weighted, composite sample). The autosampler will be programmed to collect sample water throughout an event meeting JSCS criteria, pausing when flows temporarily subside during “flashy” storm events. The autosampler will be monitored and potentially controlled by a remote laptop, but field crews may check the autosampler to ensure that it is working properly. After the whole water sample has been collected, the field crew will retrieve the sample container and deliver it on ice to the processing facility, where the stirred volume will be subsampled for ROD Table 17 COCs. Minimum analytical holding time and preservative requirements will be observed.

The automatic samplers are proposed for deployment in the private systems because the systems are too small and convey too little flow to support the use of the HVS sampling approach. Compared to a grab sample, the HVS sampling approach provides a superior characterization of chemical loading rates by accounting for the variability of COC concentrations over the range of variable discharge rates. HVS sampling also provides a means of determining COC loading rates when COC concentrations in stormwater are low. Automated samplers do not provide the same benefits as the HVS methodology, but they are superior to grab samples because they provide flow measurements that are correlated with the timing of sample collection such that samples are obtained consistent with ODEQ/EPA 2005 JSCS guidance (i.e., samples will be collected within 3 hours of the onset of discharge, and a minimum of one sample will be collected during the first flush [defined in the JSCS as the first 30 minutes after the onset of discharge]) (ODEQ and EPA 2005).

4.1.4 Manual Grab Stormwater Solids Sampling Methodology

Manual grabs of stormwater solids from manhole sumps and/or adjacent pipe inlets will be conducted in a single sampling event. Sampling will be performed in accordance with SOP A-4, Storm Drain Sampling (Appendix A).

Sample collection from manhole sumps and/or adjacent conveyance systems will incorporate material representative of the total depth of accumulated solids. The stormwater solids sampling subcontractor will select sampling equipment that is suitable for site conditions. Sampling equipment will be decontaminated prior to use. Section 4.9 of the FSP provides more detailed information on decontamination procedures.

Any standing water in the manhole sump will be pumped off to ensure collection of a representative sample of stormwater solids. Firm solids above the water line are most easily collected using simple tools such as a stainless-steel spoon, scoop, or trowel. If necessary, the spoon, scoop, or trowel may be attached to an extension pole to reach the bottom of the manhole and adjacent pipe inlets, provided representative samples can be recovered intact. Sample collection will avoid scraping the pipe walls to prevent the collection of iron precipitate. Stainless steel bucket augers (hand augers) typically have long handles (>4 ft) and can also be used to collect solids from deeper junctions. While it may be possible to sample solids in manhole sumps and laterals without confined space entry, confined space entry will likely be required to determine if sufficient solids have accumulated in the laterals for collection. If no or limited solids are present, it will be noted in the field documentation and an alternative nearby manhole may be selected for evaluation based on consultation with the HGL project manager and technical leader.

Clean and appropriate sampling equipment will be advanced into the manhole sump, where present, to collect solids in each pipe inlet entering the manhole. Solids will be described following ASTM Standard D2488 (ASTM, 2017) and USCS visual soil classification procedures. Collected solids will be placed in laboratory-provided glass jars and stored in a cooler at 0 to 6 °C until transport to the laboratory, where they will be frozen for possible future analyses if inadequate volumes are collected from sediment traps installed in the conveyance system.

4.1.5 In-Line Sediment Trap and Level-Velocity Logger Installation and Sampling Methodology

The goal of the sediment trap sampling is to deploy the equipment in locations where backflow will not occur. To that end, sediment trap inlets will be installed above the estimated high river elevation in the pipes. If river stage levels are predicted to rise above these elevations during an upcoming stormwater event, then staff (including confined space and traffic control) will be mobilized to retrieve the sediment trap sample bottles before the backflow event and replace them afterward.

If access to the city conveyance system is granted by the end of November 2021, in-line sediment traps will be installed in select locations in the city's conveyance system in December 2021. Sample bottles will be removed and replaced at the end of February, April, and June 2022 for compositing and analyses of wet season accumulation. Bottles will be deployed in June 2022 until October 2022 during the dry season analysis. The bottles could be retrieved early if wet weather arrives before the end of October.

The sampling locations are shown on Figure 3-1. Sampling of stormwater solids via in-line sediment traps is proposed to be conducted by an HGL subcontractor with confined space entry training. Sampling will be performed in accordance with SOP A-6, In-Line Sediment Trap (Appendix A).

In-line sediment traps will consist of custom stainless steel brackets holding 1-L, high-density polyethylene sample bottles. At each designated sampling location, in-line sediment traps will be installed at the bottom of the conveyance system. In-line sediment traps will be firmly secured to the conveyance system to prevent unintended transport of the equipment. It is anticipated that confined space entry procedures will be required to install the sediment traps. These procedures will be outlined in the HASP. In-line sediment trap brackets and related equipment will be decontaminated prior to installation, and new, clean laboratory-supplied 1-L bottles will be utilized within the brackets.

When the sample bottles are collected and submitted for archival and subsequent analysis after the first targeted deployment period, they will be replaced by clean and decontaminated bottles. Section 4.9 of the FSP provides more detailed information on decontamination procedures.

A Pulsar Measurement Greyline Stingray 2.0 water-level-velocity logger will also be incorporated into the stormwater sampling program in the city outfall basins to continuously measure water levels and velocities. These parameters will be converted to flow and volume using the cross-sectional geometry of the flow in the pipe during the HVS storm events as well as during the entire wet and dry seasons. The conversion to flow will be made using Manning's equation (Chow, 1959) with adaptations specific to flow in partially filled pipes:

$$Q = (1.49/n)\ A\ (R_h^{2/3})\ S^{1/2}$$

where:

Q = flow rate
n = Manning's roughness coefficient
A = cross-section area of the flow
R_h = hydraulic radius
S = slope

It is expected that during sampling events the stormwater pipes will be flowing partially full. Flow calculations for partially full pipe flow are complicated by two considerations: (1) the equations for calculating the hydraulic radius (R_h) are different depending on whether the pipe is flowing more than half full or less than half full, and (2) the Manning roughness coefficient must be considered to vary as a function of the ratio of depth of flow to diameter for the calculations to be accurate. Camp's method (Camp, 1946) will be used to determine the appropriate Manning roughness coefficient based on the depth of flow relative to the pipe diameter.

A Stingray 2.0 logger will be used during in-line sediment trap deployment periods and during city outfall basin HVS sampling events. The loggers will be mounted on stainless steel plates and securely fastened to the bottom of the stormwater pipe using small (0.25-inch) stainless steel anchor bolts and nuts. The cable from the logger module to the probe will be fastened to the pipe using the same hardware and protected from high flows. If necessary, the cable will be shielded using a 1-inch flexible electric conduit. The module will be positioned near the top of the invert, directly beneath the manhole cover, to allow easy access for downloads and inspections. The logger module will be fitted with cable strap locations, which will be used to tie the module to the top ladder rung.

At the end of each targeted deployment period, the four 1-L sample bottles will be capped and stored in a cooler at 0 to 6 °C until transport to the laboratory where they will be archived, pending compositing and analyses. The sediment traps will be in use for nine months. During the wet season, sample bottles in the traps will be collected every two months for solids compositing and analysis at the lab. Additional sample bottles will be collected during the dry season over a three-month period for separate compositing analysis. At the end of the final deployment period, in-line sediment traps and equipment will be removed from the stormwater systems.

4.1.6 Contingency Plans

4.1.6.1 HVS System Sampling

The HVS system will target the optimal 200-L total stormwater sample volume and will be collected at an average pump rate of 1.5 L/min. If the storm flow volume or flow period does not allow for attainment of this sample volume or flow rate, but still meets the JSCS criteria for a qualifying storm, the sample will be collected at an adjusted flow rate. The effect of pumping less than the optimal 200-L minimum through the HVS system will affect the achievable laboratory detection limit, although even with limited volume the detection limits for the HVS system samples will be well below those that can be achieved using conventional laboratory analyses. If river backflow is predicted to occur at the proposed HVS locations, the sampling will be conducted at the alternate locations listed in Table 3-1. For locations with pipe invert elevations less than the estimated range of wet season river elevations (4 to 10 MBDC) (AAM107 in the M-1 outfall basin and AQQ104 in the M-3 outfall basin), HGL will target events expected to meet JSCS criteria and occur near low tide.

4.1.6.2 Manual Grab Solids Sampling

Manual stormwater solids grab samples will be collected if a minimum of 226.8 grams (8 ounces) of solids are present. If less than 8 ounces of solids are present, then alternative locations will be inspected, and the location with at least 8 ounces of sediment present will be sampled. Alternative locations without at least 8 ounces of sediment present will not be sampled.

4.1.6.3 In-Line Sediment Trap Sampling

Each location includes four sample bottles, which increases the anticipated mass of collected stormwater solids compared to less bottles. If sample volume is limited, analysis of the PHSS-focused COCs (PCBs, OCPs, and dioxins/furans) will be prioritized over the remaining ROD COCs.

4.1.6.4 General

In instances where ROD COCs and conventional parameters are targeted for analysis, but the volume of stormwater solids or stormwater is limited, then analysis for PCBs, OCPs, and dioxins/furans will be prioritized over the other COCs. In these cases, the HGL sampling and analysis coordinator, in consultation with the HGL project manager, will provide the laboratory with a list of the analytical priorities for that specific sample location.

4.2 RIVERBANK FIELD CHARACTERIZATION – PHASE 1 ASSESSMENT

This section describes the riverbank assessment survey procedures for the first phase of riverbank characterization. The SIB riverbanks will be accessed by field staff via upland areas or by boat where upland access is restricted. Most areas are accessible through the shoreline facility properties, and field staff will follow the sign-in/sign-out protocols for the respective facilities. A total of 126 transects (1 per every 100 lineal ft of riverbank) will be visually inspected during the first phase riverbank assessment survey. Proposed transect locations are shown on Figure 3-2. Because homeless people are present along some areas of the riverbank (e.g., head of the SIB), an outreach strategy and protocol will be included as an attachment to the HASP.

The riverbank assessment survey will document shoreline conditions, delineate areas of potentially erodible riverbank materials, and locate areas of geotechnical movement (slope rotational failure, settlement). The riverbank assessment survey will include the entire riverbank within the SIB Project Area. The BANCS model will use survey results to complete a bank stability analysis that includes BEHI and near bank stress determinations. The riverbank assessment survey will include visually inspecting and photo-documenting the riverbank and material types to determine input parameters for the BANCS evaluation. The riverbank assessment survey will record the following observations at each survey transect:

- Height of bank – as measured from the top of the bank to the toe of the slope.

- Bankfull level – the point on the riverbank that contains normal non-flood-level flows of the river throughout the year and is typically identifiable by visible changes in topography, vegetation type, or sediment grain size. For the Willamette River, the bankfull level is approximated by the OHWM elevation, which is equivalent to 20.08 ft NAVD 88, as presented in the USACE Portland Harbor hydrology document (USACE 2014).
- Bank armoring and stabilization measures – presence, nature, extent, and qualitative condition.
- Shoreline structure on the bank – presence, description, and qualitative condition.
- Bank vegetation and root density – presence, type, and description.
- Bank composition – document visually determined soil attributes (e.g., soil textures, colors) for exposed surface soils.
- Evidence of bank erosion – consider erosion caused by runoff and overland flow, waves, and currents.
- Bank geometry – slope, height, and shape.
- Toe condition – describe the transition from bank soils to submerged sediments.
- A qualitative assessment of the potential for wind- and boat-induced wave action to contribute to erosion.

After the proposed first phase riverbank assessment survey, HGL will prepare a riverbank soil sampling plan addendum that specifies data quality objectives and proposed sampling locations. The first phase riverbank assessment would be performed when water levels are at their lowest in the SIB (anticipated to occur from fourth quarter 2021 through first quarter 2022).

The proposed two-phased approach to characterization will develop data required for determining which riverbank areas need further detailed erodibility/stability assessments by coastal and geotechnical engineers during the PDI. This data will also be used to delineate riverbank areas susceptible to erosion for future use in the RD. Coordinates of erodible and non-erodible areas will be mapped using handheld GPS units, backed up with field notes on tablets.

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5.0 REFERENCES

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TABLES

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Table 2-1
Summary of Data Gaps and Proposed Data Collection
Stormwater and Riverbank Assessment and Sampling Plan; Swan Island Basin Project Area, Portland, Oregon

Data/Analysis Type	Data Gap	Proposed Data Collection
Riverbank Characterization	Riverbanks within Swan Island Basin Project Area not adequately characterized to assess source control sufficiency and inform stabilization as part of Remedial Design.	• Conduct visual survey of physical bank conditions to evaluate erosion potential using BANCS analysis and delineate areas of potentially erodible soil and other materials. • Collect samples for ROD Table 17 COC analyses from up to 126 transects along the riverbank. • Coordinate with geotechnical sampling program to evaluate geotechnical failure potential and characterize soil conditions (e.g., grain size, soil erodibility).
Stormwater Discharge	Lack of adequate data on ROD Table 17 contaminants of concern (COCs) loading from municipal and private outfalls to determine source control sufficiency and complete the Sufficiency Assessment Report.	• Complete inventory of the status of discharges from private outfalls that discharge to areas with ROD COC exceedances in sediments. • Conduct high-volume, time-weighted sampling to support ROD COC load calculations at five municipal stormwater outfalls. • Collect stormwater grab samples and stormwater solids samples using in-line traps at 11 locations in the municipal stormwater system. • Conduct reconnaissance of six private stormwater conveyance systems where effluent has contained COCs at levels greater than ROD CULs, no data is available, or the system discharges to sediment that has had ROD CUL or RAL exceedances to determine if sampling of these systems is possible.

Table 3-1
Summary of Stormwater System Sampling Activities Locations
Stormwater and Riverbank Assessment and Sampling Plan; Swan Island Basin Project Area, Portland, Oregon

	Primary Sample Location	Sample Media and Proposed Analytical Suite						Proposed Sample Location Info				Alternate Sample Location	Sample Media and Proposed Analytical Suite						Alternate Sample Location Information		
		Stormwater			Stormwater Solids								Stormwater			Stormwater Solids			Depth (Portland Maps ft)	Pipe Elevation (COP)	Pipe Elevation (MBDC)
Basin ID	**Manhole ID**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Depth (Portland Maps ft)**	**Pipe Diameter (Portland Maps inches)**	**Pipe Invert Elevation (COP)**	**Pipe Invert Elevation (MBDC)**	**Manhole ID**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Analyte List**	**Sample Frequency**	**Collection Method**			
		City of Portland Stormwater Conveyance System											City of Portland Stormwater Conveyance System								
M-1	**AAM107[a]**	ROD Table 17 COCs, minus ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	26.3	Inlet 60 (AAM107-APX575) and outlet 60 (OFM-1)	9.5	6.58	**AAM104**	ROD Table 17, or only ROD Table 21 COCs, if limited volume	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	25	15.93	13.01
					ROD Table 17, or only ROD focused COCs, if limited volume	2 wet season samples from lateral from basin, 2 dry season samples from lateral from basin	ILS									ROD Table 17, or only ROD focused COCs, if limited volume	1 wet season sample from sub-basins, 1 dry season sample from sub-basins	ILS			
					ROD Table 17, or only ROD focused COCs, if limited volume	1 sample, from upstream side of AMM107 before equipment deployment	MSG										1 sample in each of three laterals to AAM104 before equipment deployment	MSG			
												AAJ935 (north sub-basin)				ROD Table 17, or only ROD focused COCs, if limited volume	1 wet season sample from manhole, 1 dry season sample from manhole	ILS	16.5	14.88	11.96
																	1 sample in AAJ935 before equipment deployment	MSG			
												AAJ810 (northwest sub-basin)					1 wet season sample from sub-basin, 1 dry season sample from sub-basin	ILS	16.5	15.93	13.01
																	1 sample in AAJ810 before equipment deployment	MSG			
												AAM105 (southeast sub-basin)					1 wet season sample from sub-basin, 1 dry season sample from sub-basins	ILS	20.6	16.5	13.58
																	1 sample in AAM105 before equipment deployment	MSG			
M-2	**AAM169**	ROD Table 17 COCs, minus ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	20.6	Inlets 21 (AAM169-AAM165), 60 (AAM169-AAM170), and 27 (AAM169-AAM192) and outlet 60 (OFM-2)	10.57	7.65	**AAM170 (north sub-basin)**	ROD Table 17, or only ROD Table 21 COCs, if limited volume	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	20.9	10.93	8.01
					ROD Table 17, or only ROD focused COCs, if limited volume	3 wet season samples from laterals to sub-basins, 3 dry season samples from laterals to sub-basins	ILS									ROD Table 17, or only ROD focused COCs, if limited volume	1 wet season sample from sub-basin, 1 dry season sample from sub-basins	ILS			
					ROD Table 17, or only ROD focused COCs, if limited volume	3 samples, one per lateral in AMM169 before equipment deployment	MSG										1 sample in AAJ935 before equipment deployment	MSG			
												AAM192 (southeast sub-basin)				ROD Table 17, or only ROD focused COCs, if limited volume	1 wet season sample from sub-basin, 1 dry season sample from sub-basins	ILS	18	14.97	12.05
																	1 sample in AAJ810 before equipment deployment	MSG			
												AAM165 (northwest sub-basin)					1 wet season sample from sub-basin, 1 dry season sample from sub-basins	ILS	18	14.06	11.14
																	1 sample in AAJ810 before equipment deployment	MSG			
M-3	**AAQ004[b]**	ROD Table 17 COCs, minus ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	24.6	Inlets 18 (AAQ004-AAP976) and 48 (AAQ004-AAQ-005)	6.03 (AAQ004-AAQ003)	3.11	**AAQ005**	ROD Table 17 COCs, minus ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	22.6	9.89	6.97
					ROD Table 17, or only ROD focused COCs, if limited volume	3 wet season samples from laterals to sub-basins, 3 dry season samples from laterals to sub-basins	ILS									ROD Table 17, or only ROD focused COCs, if limited volume	3 wet season samples from laterals to sub-basins, 3 dry season samples from laterals to sub-basins	ILS			
					ROD Table 17, or only ROD focused COCs, if limited volume	3 samples one per two laterals in AAQ004 before equipment deployment	MSG									ROD Table 17, or only ROD focused COCs, if limited volume	3 samples one per lateral in AMM104 before equipment deployment	MSG			

Table 3-1 (Continued)
Summary of Stormwater System Sampling Activities Locations
Stormwater and Riverbank Assessment and Sampling Plan; Swan Island Basin Project Area, Portland, Oregon

	Primary Sample Location	Sample Media and Proposed Analytical Suite						Proposed Sample Location Info				Alternate Sample Location	Sample Media and Proposed Analytical Suite						Alternate Sample Location Information		
		Stormwater			Stormwater Solids								Stormwater			Stormwater Solids					
Basin ID	**Manhole ID**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Depth (Portland Maps ft)**	**Pipe Diameter (Portland Maps inches)**	**Pipe Invert Elevation (COP)**	**Pipe Invert Elevation (MBDC)**	**Manhole ID**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Analyte List**	**Sample Frequency**	**Collection Method**	**Depth (Portland Maps ft)**	**Pipe Elevation (COP)**	**Pipe Elevation (MBDC)**
S-1	AAM131	ROD Table 17 COCs, minus ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	21.7	Inlets 27 (AAM131-AAM128) and 18 (AAM131-AAM133) and outlet 36 (OFS-1)	14.76	11.83	None proposed									
					ROD Table 17, or only ROD focused COCs, if limited volume	2 wet season samples from laterals to sub-basins, 2 dry season samples from laterals to sub-basins	ILS														
					ROD Table 17, or only ROD focused COCs, if limited volume	2 samples, one per lateral, from AMM131 before equipment deployment	MSG														
S-2	AAP957	ROD Table 17 COCs, minus ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	ROD focused COCs	3 events (2 wet season, 1 dry season)	HVS	22.1	Inlets 30 (AAP957-AAP955) and 21 (AAP957-AAP970) and outlet 36 (OFS-2)	14.71	11.79	None proposed									
					ROD Table 17, or only ROD focused COCs, if limited volume	2 wet season samples from laterals to sub-basins, 2 dry season samples from laterals to sub-basins	ILS														
					ROD Table 17, or only ROD focused COCs, if limited volume	2 samples, one per lateral, from AAP957 before equipment deployment	MSG														
				Private Conveyance System								Private Conveyance System									
USCG Marine Safety Unit (WR-198, WR-199, WR-200 or WR-201)		ROD Table 17 COCs	3 events (2 wet season, 1 dry season)	SWC	ROD Table 17, or only ROD focused COCs, if limited volume	1 sample from stormwater feature prior to equipment deployment		Not available				None proposed									
ATC Leasing / Auto Truck Transport (WR-69, WR-71 or WR-289)																					
Barge Eagle (WR-68, WR-185, or WR-186)							MSG														
NW Paperbox Manufacturing (WR-15)																					
Daimler Trucks North America Wind Tunnel / Corp 5 (WR-429)																					
Port of Portland Lagoon Avenue Property (WR-30, WR-31, WR-32, WR-33, WR-34, or WR-35)																					

Notes:
a = In-line sediment trap deployment and collection of manual solids samples are not proposed at this location due to historical and likely future river backflow. If proposed field reconnaissance during high tide indicates that a sediment trap can be installed above the highest river elevation, then a sediment trap will be installed at this location with the inlet above the highest river elevation. The proposed HVS monitoring and solids sampling location may be adjusted to AAM104, where river backflow is less likely (i.e., pipe invert elevation of 13.01 feet MBDC versus 6.58 feet MBDC at AAM107).
b = While manhole AAQ003 is closer to OFM-3, its pipe invert elevation is less than the river elevation range during the wet season (3.11 feet versus 4 to 10 feet MBDC). As a result, the proposed monitoring location was adjusted.
BES = Bureau of Environmental Services
COC = contaminant of concern
COP = City of Portland
ft = feet
HVS = high-volume, time-weighted sample
ID = identification
ILS = in-line solids (confined space entry)
MBDC = Morrison Bridge Datum Conversion. The City of Portland datum is converted to Morrison Bridge Datum (USGS gaging station 14211720, gage height of 1.55 feet above National Geodetic Vertical Datum of 1929) by subtracting 2.92. (https://www.portlandoregon.gov/transportation/article/70676)
MSG = manual solids grab (confined space entry)
NA = not applicable
ROD = Record of Decision for Portland Harbor Superfund Site (EPA 2017 and 2020)
SWC = flow-weighted, composite stormwater sample collected using Teledyne ISCO 6712C autosamplers equipped with flow meter
USCG = U.S. Coast Guard
VIS = visual system inspection

Current River Level (MBDC): https://nwis.waterdata.usgs.gov/usa/nwis/uv/?cb_00065=on&format=gif_stats&site_no=14211720&period=&begin_date=2021-01-26&end_date=2021-02-02
https://waterdata.usgs.gov/monitoring-location/14211720/#parameterCode=00065&period=P7D&compare=true
Projected River Level (MBDC): https://water.weather.gov/ahps2/hydrograph.php?gage=prto3&wfo=pqr

Table 4-1
Summary of Sample Activities, Numbers, and Analytes
Stormwater and Riverbank Assessment and Sampling Plan,
Swan Island Basin Project Area, Portland, Oregon

Sample Type	Number of Stations	Number of Samples	Analytes
Stormwater and Stormwater Solids	COP Stormwater Outfall Basin Stations: 5 (3 Events)	HVS Stormwater: 18 (including 3 equipment rinsate blanks)	Table 17 COCs
	COP Stormwater Outfall Basin HVS Stations: 5 (3 Events)	HVS Solids: 15	Table 17 COCs
	COP Stormwater Outfall Basin Stations: 11	In-Line Solids: 33	Table 17 COCs
	City and Private Systems: 13	Manual Grab Samples: 18	Table 17 COCs

Notes:
Surface samples will target the 0- to 30-centimeter depth.
Study Area = Swan Island Basin Study Area between river miles 8.1 and 9.2.
See Table 2.2 of the FSP for details on updated ROD Table 21 focused COCs and ROD Table 17 COCs.
COCs = ROD Table 17 contaminant of concern
COP = City of Portland
HVS = high-volume, time-weighted sampling
ROD = Record of Decision
SIB = Swan Island Basin

FIGURES

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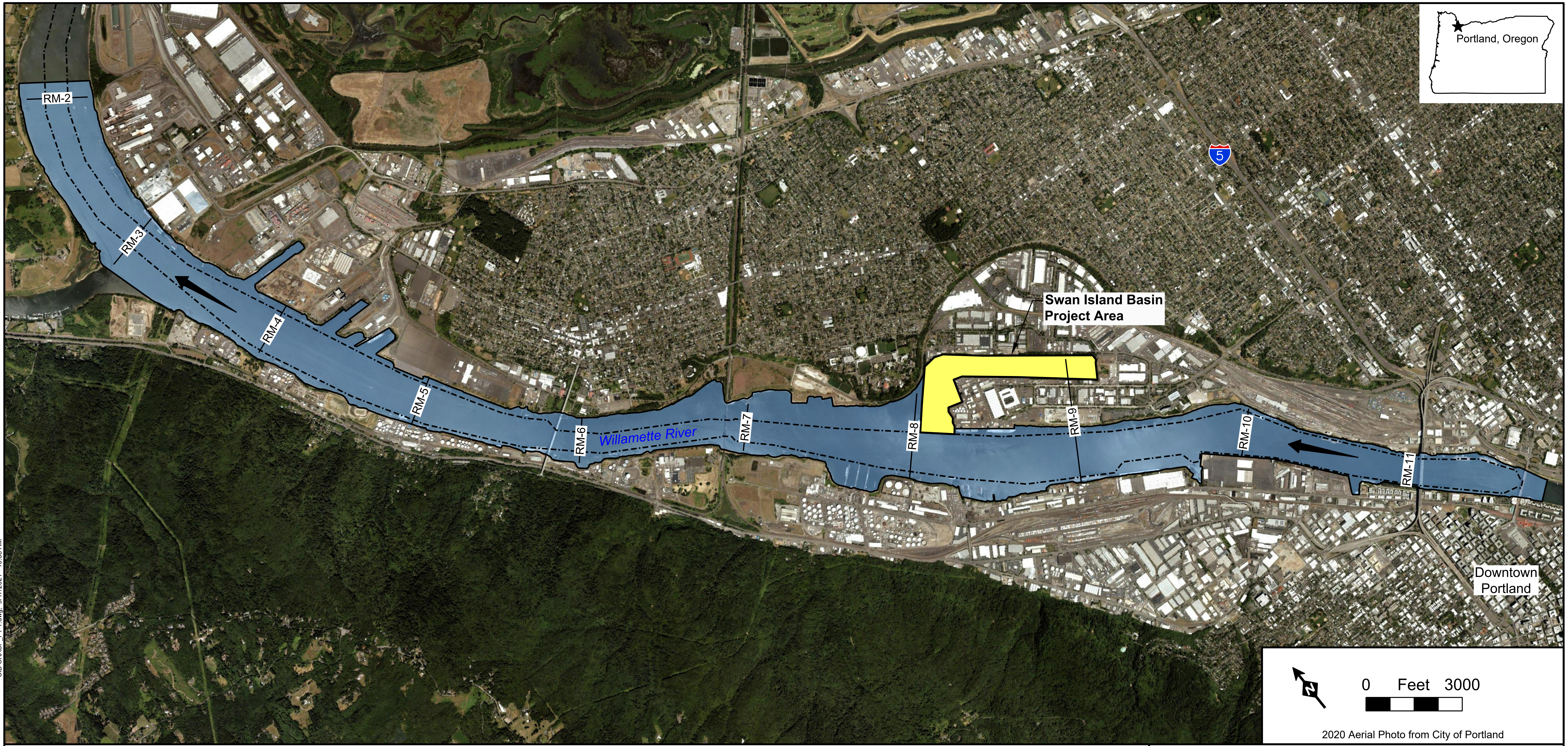

- Navigation Channel
- River Flow Direction
- Swan Island Basin Project Area
- Portland Harbor Superfund Site Boundary (River Mile 1.9 to 11.8)

Notes:
NOAA - National Oceanic and Atmospheric Administration
RM - river mile
SIB - Swan Island Basin

Source:
NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL:
https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf
- Navigation Channel

Figure 1-1
SIB Project Area Location Map

Prepared on 9/17/2021

Stormwater and Riverbank
Assessment and Sampling Plan
Swan Island Basin

PACIFIC groundwater GROUP
HGL HydroGeoLogic, Inc
MOTT MACDONALD
BRIDGEWATER GROUP

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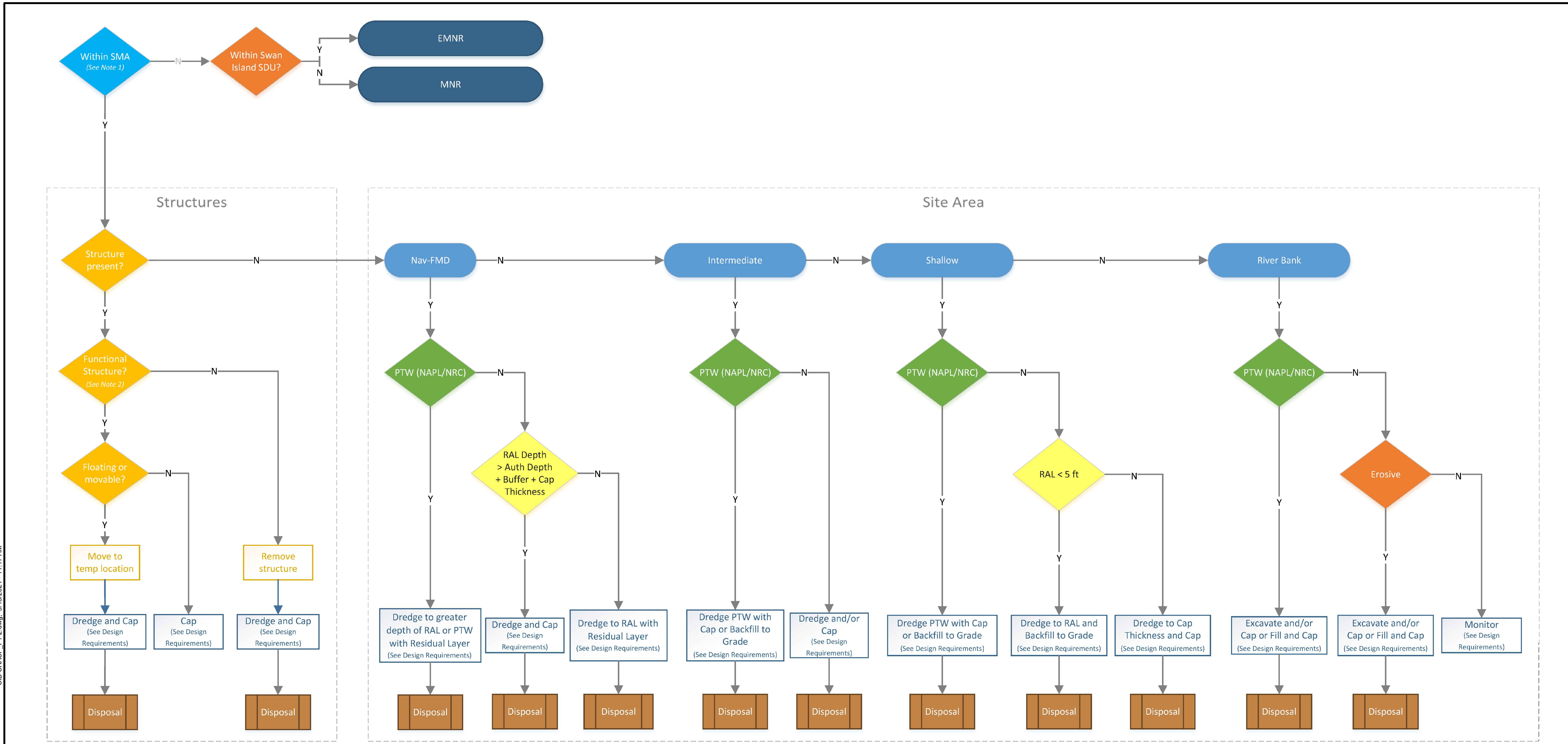

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Notes:
EMNR - enhanced monitored natural recovery
EPA - U.S. Environmental Protection Agency
MNR - monitored natural recovery
NAPL - non-aqueous phase liquid
Nav-FMD - Navigation Channel - Future Maintenance Dredge Area
NRC - not reliably contained
PHSS - Portland Harbor Superfund Site
PTW - principal threat waste
RAL - Remedial Action Level
ROD - Record of Decision
SDU - Sediment Decision Unit
SMA - Sediment Management Area

(1) Contamination is defined in three dimensions.
(2) Currently operating or used to stabilize bank. Service life > 50 years.

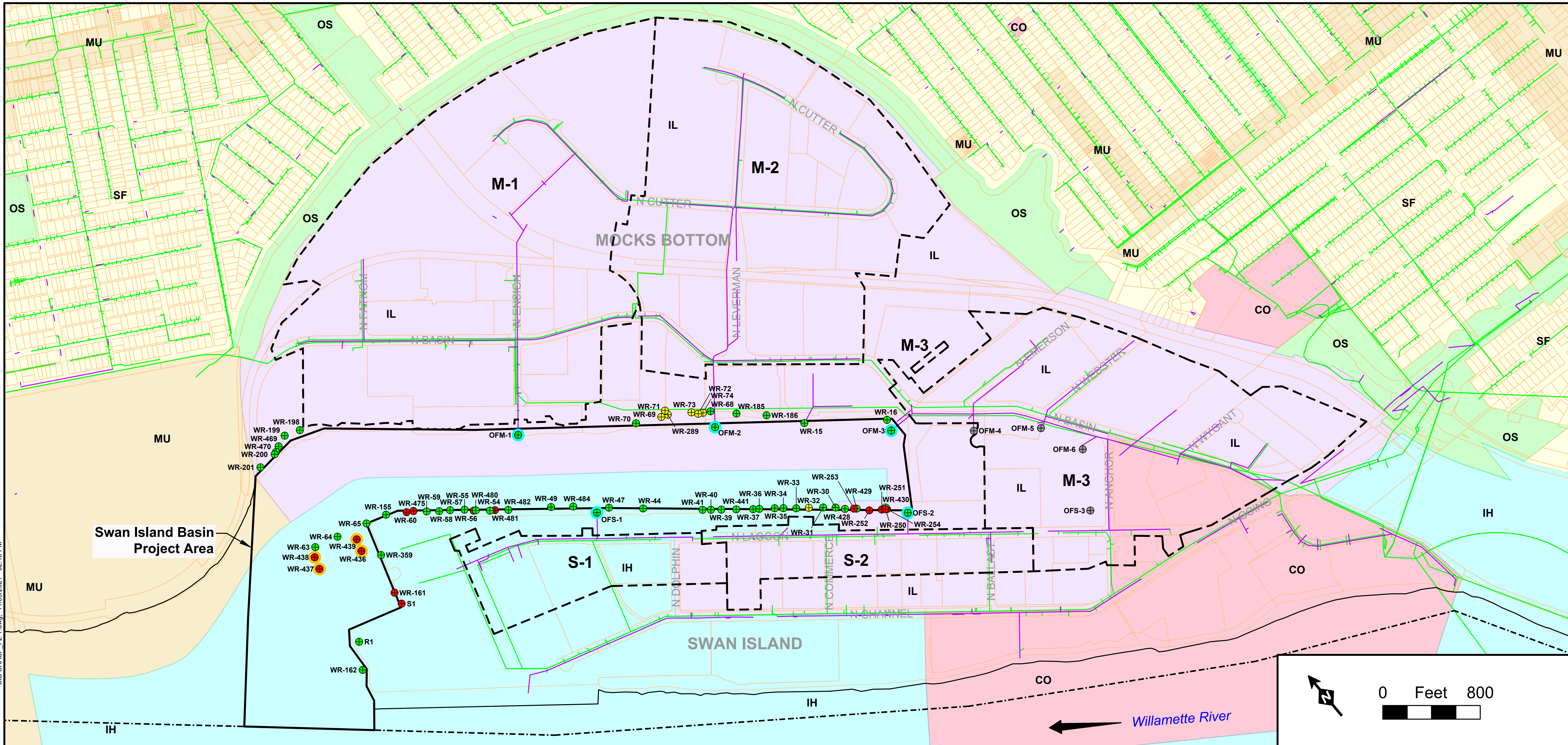
Source:
PHSS ROD, EPA, January 2017, Figure 28

Figure 1-2
Technology Application Decision Tree

Prepared on 9/15/2021

Stormwater and Riverbank
Assessment and Sampling Plan
Swan Island Basin

PACIFIC groundwater GROUP
HGL HydroGeoLogic, Inc
MOTT MACDONALD
BRIDGEWATER GROUP



Drainage Basin
Navigation Channel
Tax Lot Boundary

Zoning

IH	Heavy Industrial	MU	Mixed Use Residential
IL	Light Industrial	SF	Single Family Residential
CO	Commercial	OS	Parks and Open Space

Collection Lines

Stormwater Line
Sewer Line

Outfalls

Active
Inactive
Abandoned
Unknown
Active - City of Portland Municipal Outfalls (M-1, M-2, M-3, S-1 and S-2)
Inactive - Former Non-Contact Cooling Water Discharge Points (WR-436 through WR-439)

Notes:
NOAA - National Oceanic and Atmospheric Administration
SIB - Swan Island Basin

Sources:
(1) City of Portland Bureau of Environmental Services
- Outfalls
- Drainage Basins (except S-1)
- Collection Lines
(2) Vigor Stormwater Program Staff
- Portland Shipyard Outfalls (June 21, 2021)
- Drainage Basin S-1
(3) Oregon Metro Regional Land Information System
- Zoning (January 26, 2021)
- Tax Lots (July 23, 2020)
(4) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf
- Navigation Channel

Figure 2-1
SIB Upland Area Zoning and Drainage Basins

Prepared on 11/9/2021

Stormwater and Riverbank Assessment and Sampling Plan
Swan Island Basin

PACIFIC groundwater GROUP
HGL HydroGeoLogic, Inc
MOTT MACDONALD
BRIDGEWATER GROUP

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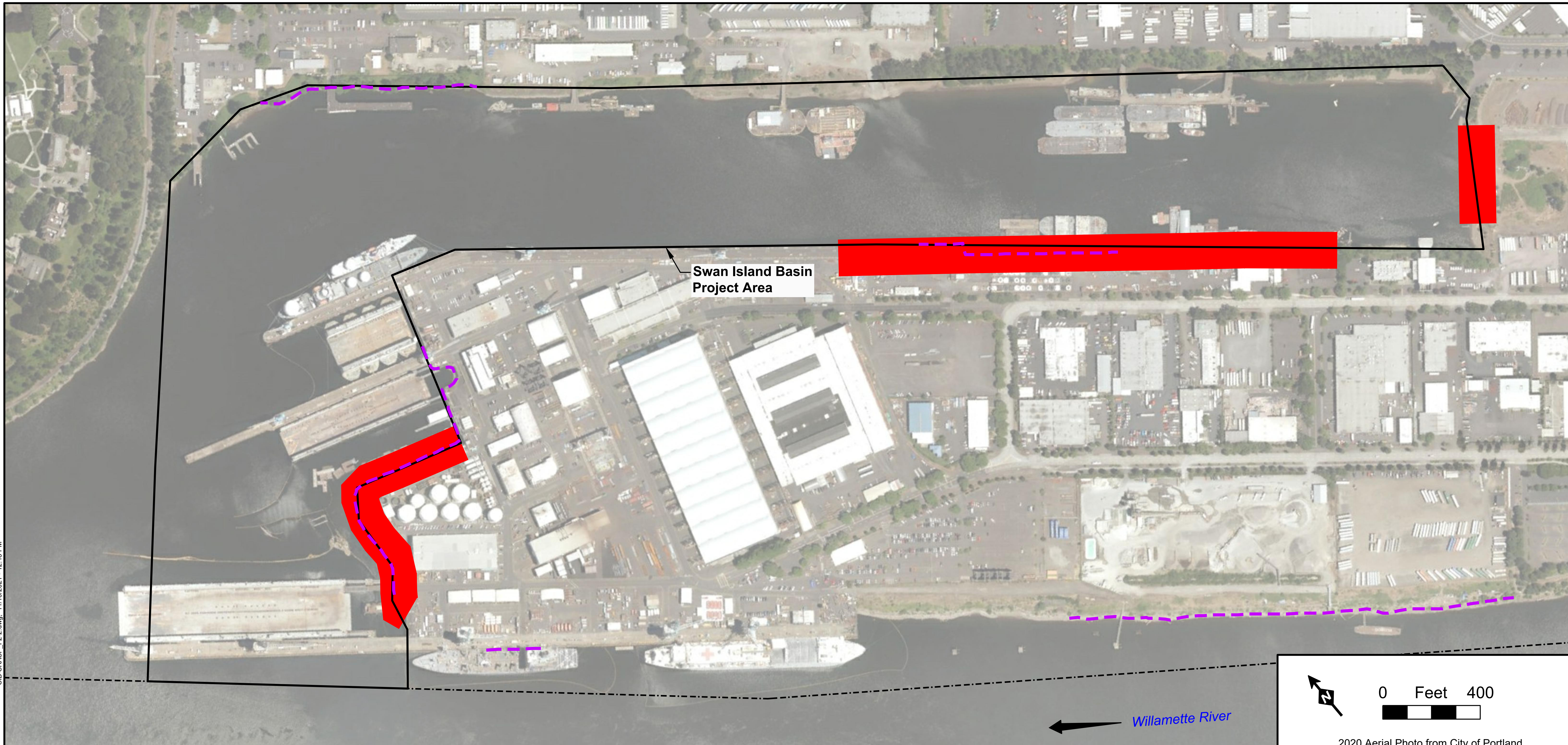

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- Known Contaminated Riverbanks (2017 ROD)
- Previous Riverbank Investigation Areas Exceeding Cleanup Levels
- Navigation Channel
- River Flow Direction

Notes:
EPA - U.S. Environmental Protection Agency
NOAA - National Oceanic and Atmospheric Administration
PHSS - Portland Harbor Superfund Site
ROD - Record of Decision

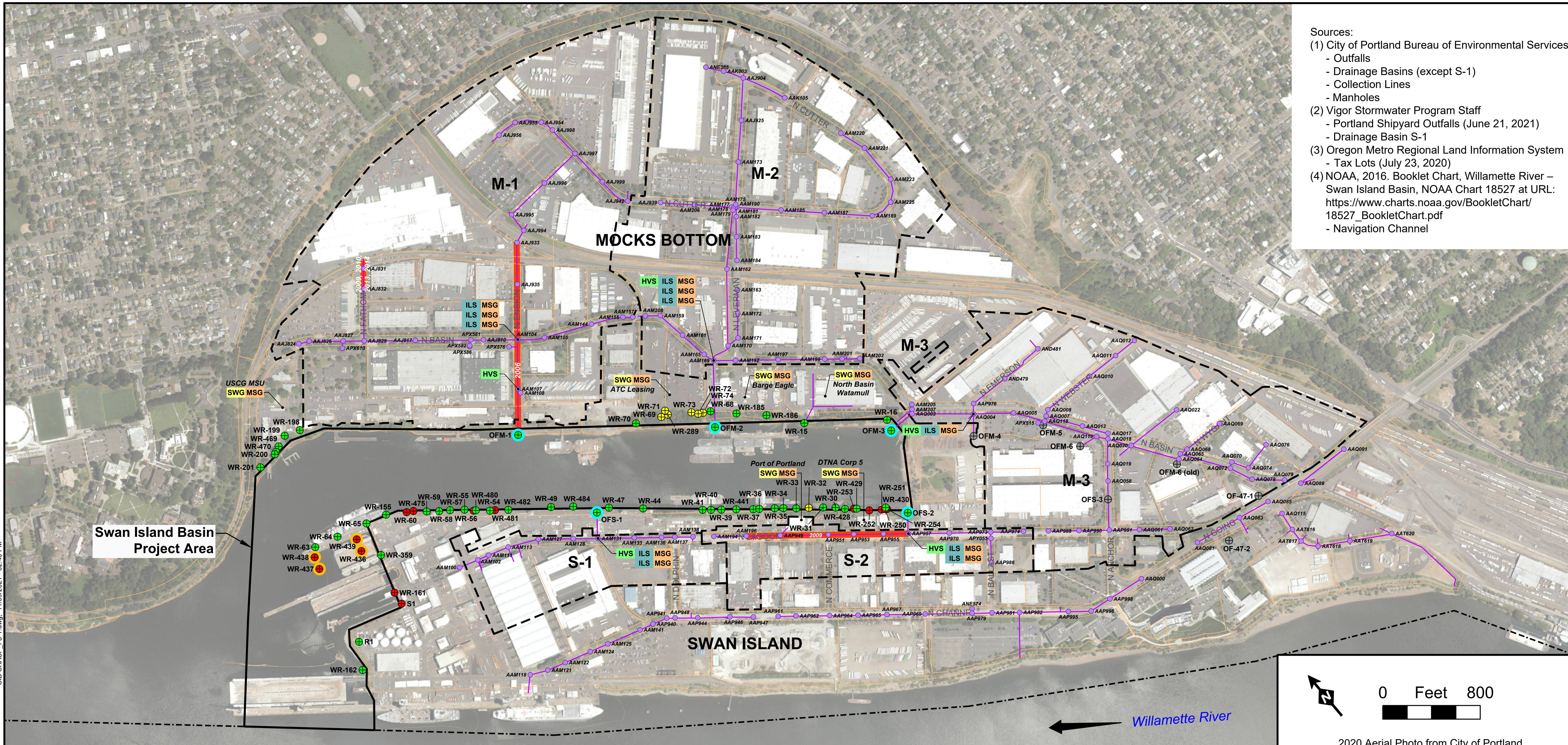
Sources:
(1) Adapted from: Figure 31d from EPA, 2017. ROD, PHSS, Portland, Oregon.
- Known Contaminated Riverbanks
(2) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf
- Navigation Channel

Figure 2-2
Known Contaminated Riverbanks

Prepared on 11/10/2021

Stormwater and Riverbank Assessment and Sampling Plan
Swan Island Basin

PACIFIC groundwater GROUP
HGL HydroGeoLogic, Inc
MOTT MACDONALD
BRIDGEWATER GROUP



Sources:
(1) City of Portland Bureau of Environmental Services
- Outfalls
- Drainage Basins (except S-1)
- Collection Lines
- Manholes
(2) Vigor Stormwater Program Staff
- Portland Shipyard Outfalls (June 21, 2021)
- Drainage Basin S-1
(3) Oregon Metro Regional Land Information System
- Tax Lots (July 23, 2020)
(4) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf
- Navigation Channel

Stormwater Line
2006 Stormwater Line Cleaning
AAP951 Manhole
Drainage Basin
Navigation Channel
Tax Lot Boundary

Proposed Sampling Methods

SWG Stormwater Grab
ILS In-Line Solids
HVS In-Line Solids and Stormwater
MSG Manual Solids Grab

Symbols repeated for sampling of multiple laterals at indicated manhole

Outfalls

Active
Inactive
Abandoned
Unknown
Active - City of Portland Municipal Outfalls (M-1, M-2, M-3, S-1 and S-2)
Inactive - Former Non-Contact Cooling Water Discharge Points (WR-436 through WR-439)

Notes:
HVS - High Volume Sampling
NOAA - National Oceanic and Atmospheric Administration
RI/FS - Remedial Investigation/Feasibility Study
ROD - Record of Decision
USEPA - United States Environmental Protection Agency

(1) The high volume sampling system sampling methodology includes pumping stormwater at a consistent rate over the duration of the storm and running high volumes of water through the HVS system to distinguish between the dissolved and solids fractions and obtain ROD Cleanup Levels for focused contaminants of concern.
(2) The in-line sediment trap design is similar to that utilized in the USEPA-approved Round 3A Stormwater Field Sampling Plan, Portland Harbor RI/FS (LWG, 2007). If possible, one trap will be installed in each lateral.
(3) Manual stormwater solid grab samples will be collected at time of manhole entry if a minimum of 8-oz of solids are present in manhole/lateral. If less then 8-oz of solids are present, then the manual grab sample locations shall be abandoned and alternative upstream locations will be inspected and selected.
(4) Stormwater grab samples will be collected using ISCO auto-samplers.
(5) Where visual outfall inspections reveal the presence of solids, a single composite manual grab sample will be collected from all outfalls on the property.

Figure 3-1
Proposed Stormwater Sampling Locations

Prepared on 11/9/2021

Stormwater and Riverbank Assessment and Sampling Plan
Swan Island Basin

PACIFIC groundwater GROUP
HGL HydroGeoLogic, Inc
MOTT MACDONALD
BRIDGEWATER GROUP

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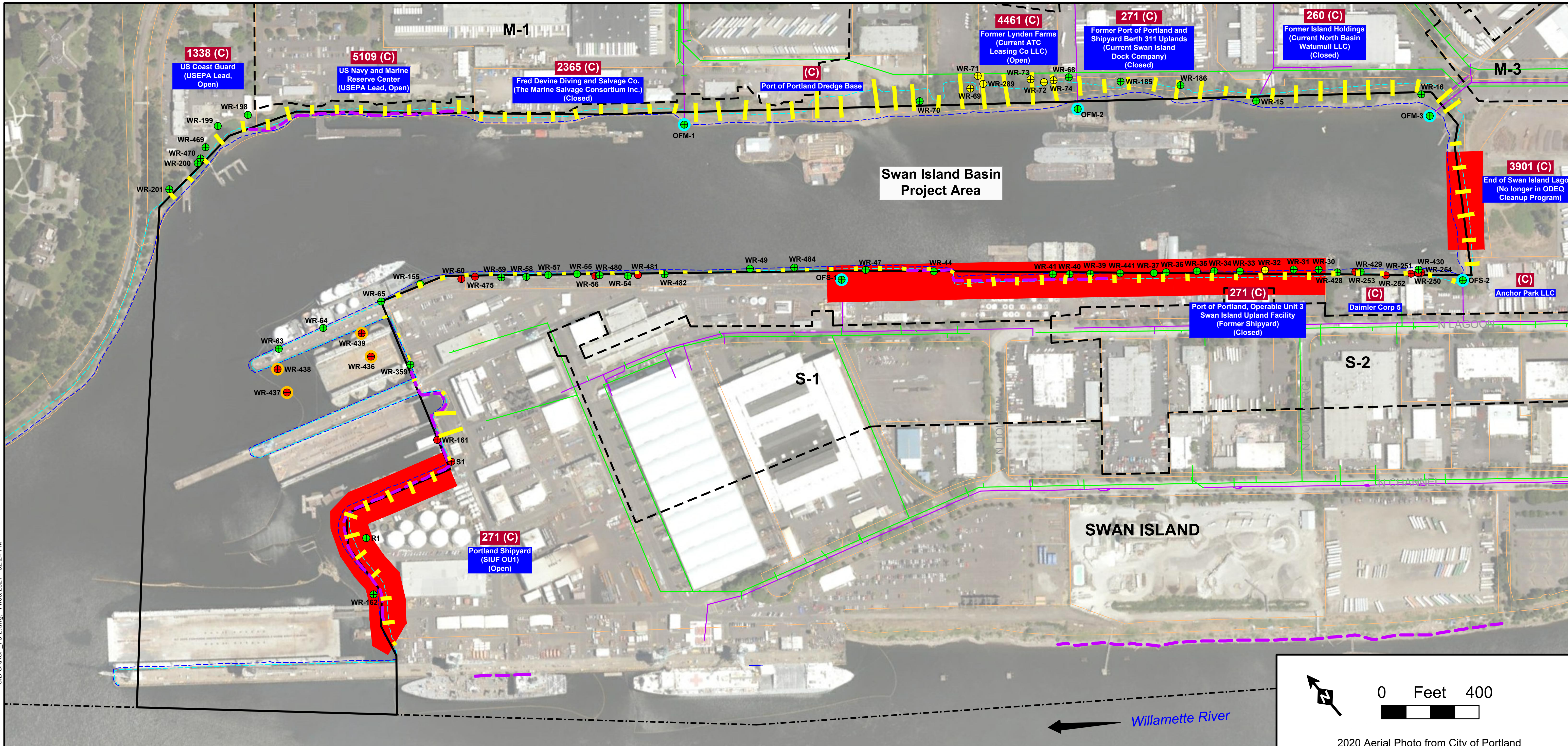

Drainage Basin
Navigation Channel
Tax Lot Boundary

Riverbank Investigations

Riverbank Sampling Transect (proposed)
Known Contaminated Riverbanks
Previous Riverbank Investigation Areas Exceeding Cleanup Levels
Mean Low Water (7.28 feet NAVD88)
Ordinary High Water (20.08 feet NAVD88)

Collection Lines

Stormwater Line
Sewer Line

Outfalls

Active
Inactive
Abandoned
Unknown
Active - City of Portland Municipal Outfalls (M-1, M-2, M-3, S-1 and S-2)
Inactive - Former Non-Contact Cooling Water Discharge Points (WR-436 through WR-439)

Notes:
ODEQ - Oregon Department of Environmental Quality
OU - Operable Unit
NAVD88 - North American Vertical Datum of 1988
NOAA - National Oceanic and Atmospheric Administration
PHSS - Portland Harbor Superfund Site
ROD - Record of Decision
SIUF - Swan Island Upland Facility
USEPA - United States Environmental Protection Agency

Sources:
(1) PHSS ROD, USEPA, January 2017
- Known Contaminated Riverbanks
(2) Ash Creek Associates, 2012a and b
- Previous Riverbank Investigation Areas Exceeding Cleanup Levels (Shipyard)
(3) Groundwater Solutions Inc., 2013
- Previous Riverbank Investigation Areas Exceeding Cleanup Levels (End of Lagoon)
(4) City of Portland Bureau of Environmental Services
- Outfalls
- Drainage Basins (except S-1)
- Collection Lines
(5) Vigor Stormwater Program Staff
- Portland Shipyard Outfalls (June 21, 2021)
- Drainage Basin S-1
(6) NOAA, 2016. Booklet Chart, Willamette River – Swan Island Basin, NOAA Chart 18527 at URL: https://www.charts.noaa.gov/BookletChart/18527_BookletChart.pdf
- Navigation Channel
(7) Oregon Metro Regional Land Information System
- Tax Lots (July 23, 2020)
(8) USEPA Riverbank Guidance, Figure 3 RB Conceptual Diagrams, December 2019
- Mean Low Water
- Ordinary High Water

Figure 3-2
Proposed Riverbank Characterization Transects

Prepared on 11/9/2021

Stormwater and Riverbank Assessment and Sampling Plan
Swan Island Basin

PACIFIC groundwater GROUP
HGL HydroGeoLogic, Inc
MOTT MACDONALD
BRIDGEWATER GROUP

SIB-SRASP_F3-2.dwg, 11/09/2021 - 02:24 PM

APPENDICES

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APPENDIX A

STANDARD OPERATING PROCEDURES

- HGL SOP 300.04, Field Logbook Use and Maintenance
- HGL SOP 403.02, Hand-Operated Auger Soil Sampling
- HGL SOP 403.03, Soil or Sediment Sample Composting
- HGL SOP 403.04, Direct-Push Technology Soil Sampling
- HGL SOP 403.06, Surface and Shallow Depth Soil Sampling
- HGL SOP 403.07, Borehole Logging
- HGL SOP 403.08, Sediment Sampling
- HGL SOP 411.02, Sampling Equipment Cleaning and Decontamination
- HGL SOP 411.03, Subsurface Utility Avoidance
- Pacific Groundwater Group SOP A-1, Hydrocarbon Field Screening (Integral, 2004)
- Pacific Groundwater Group SOP A-2, PID Screening and Calibration Procedures (AECOM and Geosyntec, 2018a)
- Pacific Groundwater Group SOP A-3, Sampling Photography
- EPA SOP A-4, Storm Drain Sampling
- Gravity SOP A-5, Gravity Marine HVS Sampling
- FMC SOP A-6, In-Line Sediment Trap
- Pacific Groundwater Group SOP A-7, Horizontal and Vertical Control

SOP 300.04, SIB Project Area, PHSS
(Source: Field Logbook Use and Maintenance)

Field Logbook Use and Maintenance	SOP No.: 300.04 (formerly 4.07)
	SOP Category: QA/QC
	Revision No.: 3
	Revision Date: November 20, 2019
	Review Date: November 2021

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the methods for use and maintenance of field logbooks. This procedure outlines methods, lists examples for proper data entry into a field logbook, and provides the standardized HGL format. Field logbooks provide a means for recording observations and activities at a site and are intended to provide sufficient data and observations to reconstruct field events. Logbooks are a primary source of evidence referenced during legal proceedings. The overall requirement is to document field activities without having to rely on memory.

2.0 SCOPE AND APPLICATIONS

This procedure provides guidance for logbook use and maintenance during routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the assigned HGL project manager and the HGL project quality assurance/quality control officer. Consult the project-specific planning documents for other documentation requirements that apply to the project.

3.0 GENERAL REQUIREMENTS

All project work must be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified project requirements must be justified to and authorized by the project manager and/or the relevant program manager and documented in the planning documents after consultation and approval by the client (refer to change or variance documentation requirements in the planning documents). Deviations from requirements are documented sufficiently to re-create the modified process and/or product and associated approvals.

All field personnel present on site to conduct work related to environmental projects are responsible for documenting field activities in project field logbooks. If field personnel are working in teams, one team member should be assigned to document the work performed. Documentation in the logbooks must be legible, and the logbooks must be maintained over the course of the project in accordance with this SOP.

The HGL field team leader, or approved designee, prepares daily logs to provide clients records of significant events, observations, and measurements taken in the field. These daily logs rely on documentation from the logbooks and should match.

The HGL field team leader should check logbook entries at the end of each field day to ensure that they are complete/adequate and communicate any deficiencies and corrective measures immediately. Logbook entries should be reviewed on a regular basis by the project manager or an approved designee to verify that they have been completed in accordance with this SOP. This could be done as part of the three-phase control inspections for each task or definable feature of work. Regular reviews of logbook ensure that adjustments to the information in the logbook, if needed, can be made early on in the performance of the task and establish expectations for documented information.

4.0 PROCEDURE

4.1 INTRODUCTION

Field logbooks provide a means for recording and documenting for the record observations and activities at a site. Field logbooks are intended to provide sufficient data and observation notes to enable participants to reconstruct events that occurred while performing field activities and to refresh the memory of field personnel when drafting reports or giving testimony during legal proceedings. As such, all entries must be as factual, detailed, and as descriptive as possible so that a particular situation can be reconstructed without reliance on the memory of field crews. Field logbooks are not intended to be used as the sole source of project or sampling information. A sufficient number of logbooks are be assigned to a project to ensure that each field team has a logbook at all times.

4.2 FIELD LOGBOOK IDENTIFICATION

Field logbooks are bound books with consecutively prenumbered pages. Logbooks are permanently assigned to field personnel for the duration of the project or sampling event. When not in use, the field logbooks are to be stored in site project files. If site activities stop for an extended period (2 weeks or more), field logbooks are be stored in the project files in the appropriate HGL office. The field logbooks are be scanned on a regular basis, grouped in files by field event and by logbook, and stored electronically in the proper project file located on SharePoint.

The cover of each logbook contains the following information:

- Organization to which the book is assigned (HGL),
- Site name (including operable unit designation),
- Project number,
- Book number, and
- Start and end dates of the information in the logbook.

4.3 LOGBOOK ENTRY PROCEDURES

Every field team must have a logbook, and each field activity is be recorded in the logbook by a designated field team member to provide daily records of significant events, observations, and measurements during field operations. Beginning on the first blank page and extending through as many pages as necessary, the following list provides examples of useful and pertinent information that may be recorded (optional).

- Serial numbers and model numbers for equipment that will be used for the project duration,
- Formulas, constants, and example calculations,
- Useful telephone numbers, and
- County, state, and site address.

Entries into the logbook may contain a variety of information. At a minimum, the following information must be recorded on the first page of the logbook entry for each workday:

- Date (on all pages),
- Site name, site location, and project number,
- Weather at start of day and projected for the day (changes during the day should be documented at the time of the change),
- Names of field personnel and subcontractors present and directly involved in the field activities, with their initials in order to reference them by initials during the day to facilitate note taking,
- Level of personal protective equipment being used on the site,
- Equipment used and calibration procedures followed,
- Start time, and
- Any field calculations.

In addition, information recorded in the field logbook during the day includes, but is not limited to, the following:

- Sample description including sample numbers, collection time, depth, volume, type and number of containers, preservative, and media sampled;

- Information on field quality control samples (e.g., duplicates, trip blanks, rinsates, and matrix spike/matrix spike duplicates [MS/MSDs]);

- Sample courier airbill numbers and associated chains of custody numbers;

- Observations about site and samples (odors, appearances, etc.);

- Information about any activities, extraneous to sampling activities, that may affect the integrity of the samples;

- Any public involvement, visitors, or press interest, comments, or questions; as well as times present at site;

- Equipment used on site including time and date of calibration along with calibration gas/fluid lot numbers and expiration dates, and calibration results;

- Background levels of each instrument and possible background interferences;
- Instrument readings for the borehole, cuttings, or samples in the breathing zone and from the specified depth of the borehole, etc.;
- Field parameters (pH, specific conductivity, etc., as required by the sampling method and planning documents);
- Unusual observances, irregularities, or problems noted on site or with instrumentation used;
- Maps or photographs acquired or taken at the sampling site, including photograph numbers and descriptions;
- A photographic log that lists subject, person taking photograph, distance to subject, direction, time, photograph number, and noteworthy items for each photograph stating what feature/item the photo is documenting;
- A description of the investigation-derived waste (IDW) generated, the quantity generated, and the manner of IDW storage employed; and
- Forms numbers/titles and any information contained therein used during sampling (Note that a form does not take the place of the field logbook.).

All logbook entries are made in indelible black or blue ink. No erasures are permitted. If an incorrect entry is made, the data is crossed out with a single strike mark and initialed and dated by the originator. Entries are be organized into easily understandable tables if possible. A sample format is shown in Attachment 1. A Logbook Quick Guide, which provides logbook entry requirements and suggestions, is included as Attachment 2. This guide can be copied and taped to the inside cover of a logbooks for quick reference.

All logbook pages are initialed and dated at the top of each page. The time (in 12- or 24-hour format) is recorded next to each entry. No pages or spaces are left blank. If the last entry for a day is not at the end of a page, a diagonal line is drawn through the remaining space, and the line is signed and dated.

Logbooks can become contaminated when used in the field. Every effort should be made by the field team to avoid contaminating the logbook. Logbooks can be kept in seal-top poly bags, or temporary plastic covers may be used.

4.4 REVIEW

The assigned field team leader, or an approved designee, checks field logbooks for completeness and accuracy on an appropriate site-specific schedule determined by the project leader. Any discrepancies in the logbooks are noted and returned to the originator for correction. The originator or other field team member knowledgeable about the field task reviews the comments, makes appropriate revisions, and signs and dates them. The reviewer verifies that revisions have been made before placing the logbook photocopies on the project file in SharePoint.

5.0 REVISION HISTORY

Revision 0		Initial Release
Revision 1	December 2010	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	November 20, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

ATTACHMENTS

Attachment 1 – Example Field Logbook
Attachment 2 – Logbook Quick Guide

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ATTACHMENT 1
EXAMPLE FIELD LOGBOOK

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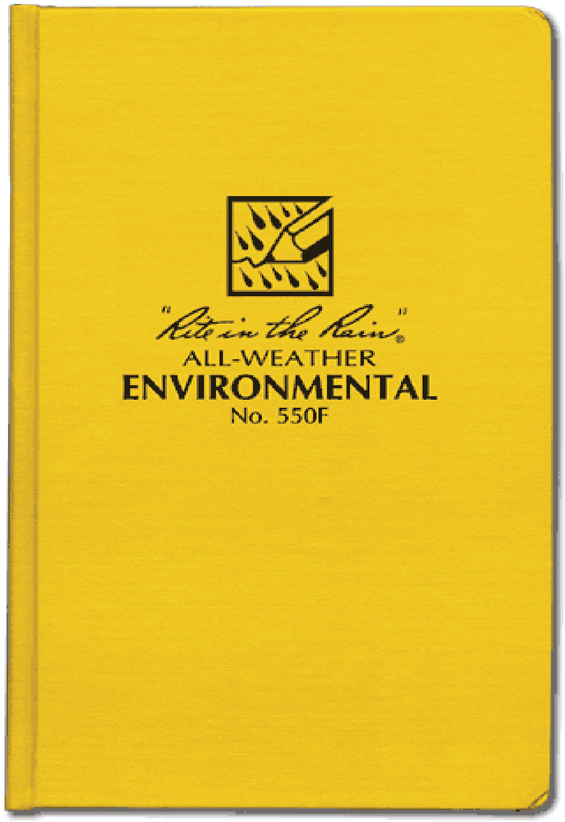
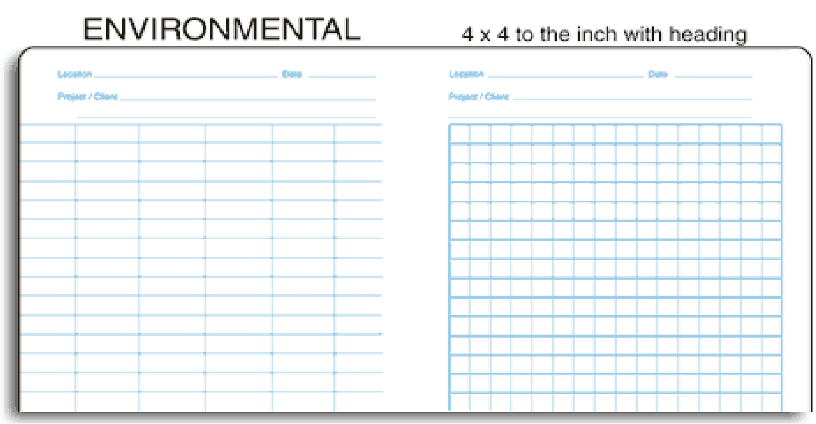
ATTACHMENT 1
Example Field Logbook





INFORMATION RECORDED IN THE FRONT OF LOG BOOKS (OPTIONAL)

- serial/model #s of equipment (meters)
- formulas, constants, example calcs
- useful phone #s
- site address

DAILY RECORDING REQUIREMENTS

- Initials and date (top of every page)
- start time
- weather
- decon methods (you may cross reference a previous days method if identical)
- personnel present on site
- ppe
- signature of individual recording info
- equipment/procedures used
- sample descriptions (time, depth, volume, containers, preserv, etc.)
- QC samples (field and lab)
- observations
- field parameters
- maps/photos drawn or taken
- form #s
- lost/voided paperwork

Photo log:
subject of photos.
distance to subject
person taking photo.
distance / direction.
Time / photo / Roll #.
Note any items.

When using a field form information recorded in the field does not need to be written twice. Cross reference the field form # in the log book and record the information only on the appropriate field form.

DO NOT LEAVE ANY BLANK SPACES/PAGES.
If a page is accidentally left blank or there is unused space at the end of a day's entry draw a diagonal line through the space and initial and date the line.

Anna Vogel AV 11/6/95
1

November 6, 1995, AX1015.13.00

pH Meter
Hach
Model # = 12345
Serial # = 6789
AV

Conductivity Meter
Hach
Model # = 12345
Serial # = 6789
$c^2 = a^2 + b^2$
if $a = 3$
if $b = 4$
Then: $c^2 = 3^2 + 4^2$
$c^2 = 25$
$c = \sqrt{25}$
$c = 5$
$\pi = 3.14159$
AV

Anna Vogel home # 123-4567
UOS Denver Office # 303/296-9700
UBS San Francisco # 415/774-2700 (Travel)
AV

Smith Site
Badger County, Colorado
Address: 1234 W. Main Street
Manzano, Colorado 00000
Directions to Site:
West on I-70
Exit 95B.
Head South approx. 3 miles
Site is on East side of dirt road.
AV

AV 11/6/95
2

November 6, 1995 Site Visit
0700 Arrive on site
Weather: 80°, sunny, slight breeze (~5mph) from southwest.
UOS Field Team: EPA OSC:
M.R. Smith J.P. Scarton
K.W. Wagner
P.R. Lane
PRP representative, L.M. Stein, will be accompanying the UOS Field Team.
Personal Protective Equipment - LEVEL D will be used on-site (refer to site-specific health & safety plan).
All equipment will be deconed as follows:
- Brush equipment scrub brush to remove gross particulates.
- Scrub thoroughly with Alconox/water solution.
- Rinse with reagent-grade distilled water.
- Rinse with reagent-grade Methanol.
- Rinse with reagent-grade distilled water.
Allow equipment to gravity drain
Wrap equipment in tinfoil if not immediately used.
Sample procedure:
All surface water samples will be taken using a clean decontaminated TEFLON scoop; stainless steel spoon and stainless steel bowl will be used for sediment samples.

AV 11/6/95
3

The samples will be taken from the ponds at the center of the dam opposite the outlets. (see below; refer to sample plan).
All total suspended solids (TSS) samples will be collected in a 500 ml polystyrene bottle - No preservative is necessary.
All VOA samples will be collected in two 40-ml amber glass vials and will be collected first. Preservation will be 4°C (ice).
→ Meters (pH) Decon = Rinse with reagent-grade distilled water

0730: leave trailer. Go to sample location SS-1 @ Pond A.
0745: Arrive @ POND A.
Decon. equipment as described on page 2 of this logbook.
Calibrate pH meter - Rinse probe

Time	STD	Reading	
0753	7.00	7.00	Rinse probe
0754	4.00	4.00	Rinse probe

0756 Calibrate Conductivity Meter using 10000 STD - Rinse probe

AV 11/6/95
4

Time Sample Sample# Label #
0802 VOA 81088 VOAA 101
0803 TSS 8108 TSSA 103*
Decon equipment (scoop only).
* label 102 fell in mud - destroyed it.

Field Parameters
Time pH Conductivity
0815 6.35 610
Decon equipment (meters only)
Fill out surface water quality sheet.
Note - wind speed is picking up -
The ponds become turbulent.
0829 - Leave Pond A - go to Pond B.
AV

0840 - Arrive at Pond B
Pond B sampling procedure.
0842 - Decon equipment.
Calibrate pH meter
Time STD Reading
0844 4.00 4.00 Rinse probe
0845 7.00 7.00 Rinse probe
0847 Calibrate conductivity meter
using 10000 STD - Rinse probe.
Decon sampling equipment (scoop).
Time Sample Sample# Label #
0902 VOA 81088 VOA BD 106
0903 TSS 81088 TSS BD 107
0909 Decon scoop.
AV

Rinsate Samples
Time Sample Sample# Label#
0920 VOA 81088 VOAR ~~107~~ AV 108
092..

11/6/95 AV
5

FIELD PARAMETERS
Time pH Conductivity
0924 6.00 590
Decon meters as noted on page 3
of this logbook.
Fill out surface water quality sheet.
AV

0940 - Leave Pond B - head back
to trailer to pack samples for
shipment.
0952 - Arrive at Trailer.
0959 - Complete chain-of-custody
forms for samples to be shipped.
Wrap samples according to UOS
TSOPs.
1020 - Seal cooler and attach
custody seals.
1030 - Take cooler to Federal Express
for shipping.
COC # 1234567.
1035 - Leave Federal express.
Sampling complete.

AV 11/6/95

ATTACHMENT 2
LOGBOOK QUICK GUIDE

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LOGBOOK QUICK GUIDE

TOP

Location: County/City/State
Project/Client: Project/Client Name

MINIMAL REQUIREMENTS

- times of activities (military)
- author of day's entries
- field team members
- field team member assignments
- field activities
- EPA or other regulatory personnel observing - activities
- other personnel
- public or press visitors
- equipment used
- equipment calibration information
- serial numbers of equipment
- weather
- decontamination methods
- level of PPE
- calculations used
- sample information
  - ID
  - depth
  - volume
  - containers
  - preservative
  - media
  - QC samples

LOGBOOK QUICK GUIDE

MINIMAL REQUIREMENTS (cont.)

- background levels and readings
- possible instrument interferences
- photographs
  - + number
  - + direction
  - + description
  - + photographer

OTHER REQUIREMENTS

- unusual observations
- strike through mistakes with single line
- diagonal line across unused portion of page with signature and date
- use indelible black or blue ink
- no erasable ink
- generate tables when possible for information
- leave no pages blank
- place North arrow on sketches
- leave no open lines
- staple business cards of visitors in book
- deviations from approved plans
- field forms completed

** Black text applies to all activities*
** Red text applies to activities that include sampling*

SOP 403.02, SIB Project Area, PHSS
(Source: Hand-Operated Auger Soil Sampling)

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HydroGeoLogic, Inc — Exceeding Expectations	STANDARD OPERATING PROCEDURE
	Approved by: Jeff Dick (Digitally signed by Jeff Dick DN: cn=Jeff Dick, o, ou, email=jdick@hgl.com, c=US Date: 2019.08.02 07:28:29 -04'00') Corporate Quality Manager

Hand-Operated Auger Soil Sampling	**SOP No.: 403.02 (formerly 2.03)**
	SOP Category: Environmental Services
	Revision No.: 2
	Revision Date: August 1, 2019
	Review Date: August 2021

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the standard method and equipment used to collect soil samples at the surface or in shallow subsurface using a hand auger.

2.0 SCOPE AND APPLICATION

This procedure yields a disturbed sample and applies to a wide variety of soil types including sands, clays, and silts. A hand auger is typically a small, lightweight metal cylinder (bucket), open at both ends with a cutting bit on the bottom. Diameters typically range between 1 and 4 inches. A T-shaped handle is attached to the top of the bucket by extendable rods. The augers are rotated into the ground until the bucket is full, then lifted out of the borehole and emptied. The maximum depth of hand auger investigations is typically 10 feet below ground surface. The use of an auger is of limited value in rocky soil. This procedure is not appropriate for collecting samples at a discrete depth, but may be used to collect samples at an approximate depth.

3.0 GENERAL REQUIREMENTS

All work must be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements must be sufficiently documented to re-create the modified process.

4.0 EQUIPMENT

The equipment required may include hand-operated, spiral-type, ship-type, open-tubular, orchard-barrel, open-spiral, closed-spiral, post-hole, clamshell, Edelman, or Iwan augers. Augers typically are used with 3- to 4-foot-long metal extension rods and T-handles (fixed or ratcheted). The use of stainless steel augers is preferred. Augers plated with chrome or coated with other materials, except Teflon®, cannot be used.

Sampling tools and equipment should be protected from contamination sources before sampling and decontaminated before and between sampling locations, as specified in SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.

5.0 PROCEDURES

1. Don clean gloves. Using a decontaminated stainless steel spoon or other approved utensil, remove surface vegetation and debris from the immediate area around the marked sampling point.
2. Do not allow sampling equipment to touch potentially contaminated surfaces.
3. Record the appropriate information and observations about the sample location in the field logbook.
4. Assemble the decontaminated auger, extension, and T-handle, if necessary, and advance the auger into the soil to the desired depth. Mark the length of the hand auger rods every 0.5 foot to determine auger head depth relative to the ground surface when advancing or tag the bottom of the borehole (if the borehole stays open) with a weighted tape measure or water level meter.
5. Withdraw the auger from the soil.
6. If a sample is not being collected, remove the soil from the auger bucket and repeat Steps 4 and 5. While removing the soil from the auger bucket, the subsurface lithology should be described as specified in SOP 2.14: *Geologic Borehole Logging*. If a sample is to be collected in the next depth interval, replace the auger bucket with a clean decontaminated bucket and repeat Steps 2 through 4. Change gloves at each sampling location, or each time a new sample is to be collected, to avoid cross-contamination.
7. Perform any field monitoring required in the project-specific planning documents.

If collecting samples for analyses other than volatile organic compound (VOC) analyses, refer to Steps 8 and 9.

8. Using a decontaminated stainless steel spoon, spatula, disposable scoop, remove soil from the auger bucket and place in a stainless steel or glass container. Food-grade disposable aluminum pans may also be used but cannot be reused. Clean nitrile gloves may be donned to remove soil from the auger bucket by hand. Discard the top 2 or 3 inches of soil in the auger as this soil may consist of borehole slough from above. Mix or composite soil as directed by the project-specific planning documents. Using a decontaminated spoon or other approved utensil, remove any large rocks or other organic material (worms, grass, leaves, roots, etc.). Clean nitrile gloves may also be donned to remove large rocks or other organic material by hand.
9. Using a decontaminated stainless steel spoon, spatula, or disposable scoop, as appropriate, place soil samples in appropriate containers. Clean nitrile gloves may be donned to place soil into appropriate containers. Place samples in containers defined according to analytical

needs specified in the project-specific planning documents, label samples, and then (when appropriate) pack on ice as soon as possible.

If collecting samples for VOC analysis, refer to Steps 10 and 11.

10. Remove the hand auger from the boring when the top of the specified sampling depth has been reached. Fit a slide-hammer to the top of the appropriate number of extension rods required to reach the total depth of the hole. Attach an impact sampler to the bottom of the extension rod(s) and drive the impact sampler into the soil to a depth of at least 6 inches. Remove the sampler from the borehole.
11. Collect VOC samples in accordance with SOP 403.01.0: *VOC Soil Sample Collection*. When samples are being collected for multiple analyses, samples that can be degraded by aeration (e.g., VOCs) are collected first and with the least disturbance possible to minimize analyte loss. VOC samples must not be composited.

6.0 REVISION HISTORY

Revision 0	December 2010	Initial Release
Revision 1	April 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	August 1, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

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SOP 403.03, SIB Project Area, PHSS
(Source: Soil or Sediment Sample Compositing)

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Soil or Sediment Sample Compositing	**SOP No.: 403.03 (formerly 2.04)**
	SOP Category: Environmental Services
	Revision No.: 4
	Revision Date: August 1, 2019
	Review Date: August 2021

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline methods that may be used for field compositing soil or sediment samples before they are submitted to an analytical laboratory.

2.0 SCOPE

This procedure applies to compositing soil or sediment. This procedure does not apply to sample collection, but rather to combining samples in preparation for submittal for testing. Samples for volatile organic compound analyses must NOT be composited.

3.0 GENERAL REQUIREMENTS

All work must be performed in accordance with the site- or project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements must be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

Soil or sediment that is to be sampled must be mixed as thoroughly as possible before being transferred to the sample container. Anomalous or suspected highly contaminated samples must be brought to the attention of the field manager.

- Soil or sediment that is composited must meet the following requirements:
  - Uniform collection techniques must be used to retrieve sample aliquots.
  - Aliquots must be of equal or known proportion.
  - The soil or sediment must be well mixed.
- The most common method of mixing (compositing) is referred to as quartering. The soil or sediment is placed in a pan or tray and divided into quarters. Each quarter is mixed individually, and then all quarters are mixed together to form a homogenous matrix. This procedure is repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the soil or sediment in a circular fashion and occasionally turning the soil or sediment over. Mixing bowls and

stirring devices must be stainless steel and be decontaminated prior to use. Samples are homogenized before being placed into containers, except for volatile organic analyses.

- Sampling tools, instruments, and equipment must be protected from contamination sources before use and decontaminated after use as specified in SOP 2.01: *Sampling Equipment Cleaning and Decontamination.*
- Composite samples must be packaged, labeled, and prepared for shipment in accordance with the project-specific planning documents.
- The field logbook must be completed in accordance with procedures detailed in SOP 4.07: *Field Logbook Use and Maintenance*.

5.0 RECORDS

Documentation generated as a result of this procedure must be collected and maintained in accordance with requirements specified in the project-specific planning documents.

- Complete the field logbook in accordance with procedures listed in SOP 4.07: *Field Logbook Use and Maintenance.*

6.0 REVISION HISTORY

Revision 0		Initial Release
Revision 1		Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	April 2009	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	April 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 4	August 1, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

SOP 403.04, SIB Project Area, PHSS
(Source: Direct-Push Technology Soil and Groundwater Sampling)

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HGL HydroGeoLogic, Inc — Exceeding Expectations	STANDARD OPERATING PROCEDURE
	Approved by: Dick, Jeff (Digitally signed by Dick, Jeff Date: 2020.06.18 16:04:57 -04'00') Corporate QA Manager

Direct-Push Technology Soil and Groundwater Sampling	**SOP No.: 403.04 (formerly 2.05)**
	SOP Category: Environmental Services
	Revision No.: 3
	Revision Date: June 18, 2020
	Review Date: June 2022

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the standard method and equipment used to collect soil and groundwater samples using direct-push technology (DPT).

2.0 SCOPE AND APPLICATION

The DPT soil sampling method applies to a wide variety of soil types including sands, clays, and silts. Samples may be collected from discrete intervals where high sample recovery rates can be achieved such as in clays and silts. However, where sample recovery rates are low, such as may be the case in loose sand, the sample collection depth intervals may be approximate. DPT soil sampling methods are of limited value in rocky soil. Where rocky soils limit the use of DPT, a different technology, such as hollow-stem auger drilling equipment, must be used. This procedure is appropriate for collecting groundwater samples at discrete depths.

3.0 GENERAL REQUIREMENTS

All work must be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan and project-specific quality assurance project plan for relevant health and safety and quality control requirements, respectively.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements must be sufficiently documented to re-create the modified process.

4.0 PRECAUTIONS

The following precautions should be employed during DPT sampling operations:

- Subsurface and aboveground utility lines must be identified and cleared before exploratory boring drilling activities can be performed. Procedures outlined in HGL SOP 411.03: *Subsurface Utility Avoidance*, must be followed.
- Every attempt should be made to minimize the transfer of potentially contaminated material to downhole equipment, or to any equipment and supplies stored on the site.
- Every attempt should be made to contain contaminated soil and water and to prevent further contamination of the environment.

- Sampling tools and equipment must be protected from sources of contamination before sampling and decontaminated before and between sampling, as specified in SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

5.0 DPT SAMPLING PROCEDURES

DPT soil sampling is accomplished using a Geoprobe® or other similar truck- or track-mounted hydraulic sampler. DPT involves advancing a sampling probe using direct hydraulic pressure or a hydraulically driven rotary hammer. Boreholes are typically advanced using a 2.5- to 3-inch-diameter lead sampler attached to 1- or 2-inch-diameter probe rods, which are placed under hydraulic downward pressure. In unstable soils, a dual-tube system may be used where the lead sampler and center rods are used within larger diameter probe rods to prevent caving of material into the sample interval. Sampler sizes can vary from 1.25 to 4.5 inches in outer diameter (OD); however, 2.25- to 3.25-inch OD samplers are typical. Liner sizes can vary from 1.0 to 3.0 inches in internal diameter (ID); however, 1.125- to 1.85-inch ID are liners are typical. Borings remain open only as long as necessary to collect the soil and/or groundwater samples and log the lithology, if required by the project-specific planning documents.

Specific sampling tools could require slightly different handling methods. For example, if sampling devices and probe rod extensions do not have quick-connect fittings, adjustable or pipe wrenches could be needed to change equipment configurations. The procedures described in this SOP are for power-driven DPT methods or tube samplers, and they are consistent with ASTM International Standard Guides D6282/D6282M-14 and D6001-05(2012).

5.1.1 Soil Sampling Procedures

The soil samples obtained using DPT are collected in acetate, brass, or stainless steel sampling tubes. Acetate tubes are most commonly used. Sampling is initiated at the soil interface, unless otherwise specified in the project-specific planning documents.

- Place plastic sheeting on the ground around the sampling location to prevent cross contamination.
- Attach the direct-push sampler with liner and cutting shoe to a rod extension.
- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). Remove the first 8 to 15 centimeters (cm) of surface soil from an approximately 15-cm radius around the drilling location to prevent near-surface soil particles from falling down the hole.
- Begin advancing the direct-push sampler, periodically removing accumulated soils. This step prevents accidentally brushing loose material back down the borehole when removing the sampler or adding probe rods.

- After reaching the desired depth, slowly and carefully remove the direct-push tool from the boring. If collecting a core sample, remove the cutting shoe and liner from the sampler and replace it with a precleaned thin-walled tube sampler. Insert a disposable acetate liner into the sampler with optional core catcher, and install the sampler and cutting shoe.
- Carefully lower the sampler down the borehole and gradually force the sampler into the soil. Care should be taken to avoid scraping the borehole sides when not using a dual-tube system. Hammering the probe rods to facilitate coring should be avoided, as the vibrations could cause the borehole walls to collapse.
- Once the sampler reaches the top of the sampling interval, drive the sampler down into the soil the length of the corer.
- Pull the probe rods and sampler out of the hole.
- Remove the sampler by twisting to prevent losing the core and unscrew the probe rods.
- Remove the cutting shoe and remove the acetate liner containing the core from the device.
- Carefully cut the acetate liner to expose the core.
- Screen the core with a field detector as described in the project-specific planning documents. If required by the project plans, collect volatile organic compound (VOC) samples immediately after opening the acetate liner. VOC samples must be collected in accordance with SOP 403.01: *VOC Soil Sample Collection*.
- Discard the top of the core (approximately 2.5 cm), as it will contain any material collected by the corer before penetration of the layer being sampled.
- Provide a lithologic description in accordance with SOP 403.07: Geologic Borehole Logging.
- If homogenization of the soil sample is appropriate for the remaining analytical parameters, or if compositing of different locations is desired, follow the procedures detailed in SOP 403.03: *Soil or Sediment Sample Compositing*. Otherwise, transfer the sample into an appropriate container with a stainless steel spoon or equivalent and secure the cap tightly.
- Label the sample bottle(s) with the appropriate sample label as described in the project-specific planning documents. Complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain of custody documents and record information in the field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance* and on the Field Sampling Report (Attachment 1).
- Prepare the samples for shipment in accordance with the project-specific planning documents.

- Decontaminate sampling equipment after use and between sampling locations in accordance with procedures detailed in SOP 411.02: *Sampling Equipment Cleaning and Decontamination.*
- If no more cores are needed from the borehole, abandon the borehole with bentonite grout or chips and return the surface to its initial condition (e.g., topsoil, asphalt, or pavement).
- Soil generated during DPT activities that was not used for sampling should be treated as investigation-derived waste (IDW) and managed in accordance with the project-specific planning documents.

5.1.2 Groundwater Sampling Procedures

DPT groundwater samples can be collected using a hydropunch sampler. This type of groundwater sampling is best used for characterizing a site to determine the best placement of permanent wells. Procedures for collecting a water sample with a hydropunch are discussed in detail in this section. Note that the hydraulic conductivity of a formation could affect the time required to collect a sample. That is, more time could be required if groundwater recharge is slow. In those instances, the probe rods and hydropunch sampler can remain in the ground while the rig moves to another location to allow the water to recharge. After sufficient recharge, bailing or pumping can begin again.

- Place plastic sheeting on the ground around the sampling location to prevent cross contamination.
- Attach the sealed-screen sampler (hydropunch) to the probe rods.
- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). Remove the first 8 to 15 cm of surface soil from an approximately 15-cm radius around the drilling location to prevent near-surface soil particles from falling down the hole.
- Begin advancing the hydropunch. The screen is driven to a depth such that the middle of the screen is set at the sample target depth.
- After reaching the desired depth, retract the protective outer rod of the sampler to expose the screen to groundwater. If necessary, an instrument can be lowered down through the center of the probe rods to check the water level and ensure that the sampler has sufficient water for sampling.
- Lower tubing with check valve, bailer, or peristaltic pump down through the probe rods to the screen of the hydropunch to collect the groundwater sample. Groundwater samples are collected most commonly using polyethylene or Teflon® tubing with a check valve attached to the bottom. An up/down oscillating motion on the tubing pumps the water column up in the tubing to the ground surface or until enough water volume is in the tubing for the samples. Groundwater samples are collected directly from the bottom of the tubing, after removing the check valve, and placed in sample containers according to the project-specific planning documents.

- Unless otherwise specified in the project-specific planning documents, collect the groundwater samples without purging sediment or groundwater to minimize disturbance to the sample.
- If sediment is expected in the sample, consider using sample containers without a hydrochloric acid preservative. Mixing the sediment often found in direct push groundwater samples with the hydrochloric acid causes a reaction that generates a gaseous product that creates unwanted headspace in the groundwater sample.
- If a bailer is used, retrieve the sample from the bailer and place it in an appropriate sample container.
- If a peristaltic pump is used, fill the appropriate sample container from the pump effluent tubing.
- If required, place a portion of the sample in a container to collect field parameters (temperature, pH, conductivity, dissolved oxygen, oxygen reduction potential, and turbidity).
- Label the sample bottles with the appropriate sample labels as described in the project-specific planning documents. Complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain of custody documents and record information in the field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance* and on the Field Sampling Report (Attachment 1).
- Prepare samples for shipment in accordance with the project-specific planning documents.
- Pull the rods and hydropunch sampler from the hole.
- Decontaminate sampling equipment after each use and between sampling locations in accordance with procedures detailed in SOP 411.02: *Sampling Equipment Cleaning and Decontamination.*
- If additional samples are not needed from the borehole, abandon the borehole with bentonite chips and return the surface to its initial condition (e.g., topsoil, asphalt, or pavement).
- Manage IDW generated during hydropunch sampling in accordance with the project-specific planning documents.

6.0 RECORDS

Documentation generated as a result of this SOP must be collected and maintained in accordance with requirements specified in the project-specific panning documents.

- Document all daily field activities in the field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance.*
- Complete a Field Sampling Report (Attachment 1) for each soil and groundwater sample.

7.0 REFERENCES

ASTM International (ASTM). D6282/D6282M-14: Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations.

ASTM. D6001-05(2012): Standard Guide for Direct-Push Groundwater Sampling for Environmental Site Characterization.

8.0 REVISION HISTORY

Revision 0	April 2009	Initial Release
Revision 1	April 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	February 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	June 18, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.05 to 403.04.

ATTACHMENTS

Attachment 1 – Field Sampling Report

ATTACHMENT 1
FIELD SAMPLING REPORT

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FIELD SAMPLING REPORT

LOCATION:	PROJECT NAME:
SITE:	PROJECT NO:

SAMPLE INFORMATION

SAMPLE ID:	DATE:____________________ TIME:_________________
MATRIX TYPE:	ENTER SAMPLE NUMBERS FOR QC SAMPLES/ BLANKS ASSOCIATED WITH THIS SAMPLE:
SAMPLE COLLECTION METHOD:	MATRIX SPIKE (MS): _______________
LOW-FLOW BAILER PASSIVE OTHER_________	MATRIX SPIKE DUP (SD): ______________
LOT CONTROL #: ___ ___ ___ ___	FIELD DUP (FD): ______________
(Ambient Blank # - Equipment Blank # - Trip Blank # - Cooler #)	AMBIENT BLANK (AB): _____________
CHAIN-OF-CUSTODY #: ____________________	EQUIPMENT BLANK (EB): _____________
SAMPLE BEG. DEPTH (FT):	TRIP BLANK (TB): ____________
SAMPLE END DEPTH (FT):	
GRAB ( ) COMPOSITE ( )	

CONTAINER		PRESERVATIVE/	ANALYTICAL	ANALYSIS
SIZE/TYPE	#	PREPARATION	METHOD	

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st (TOC):	COLOR:	
2nd (BZ):	ODOR:	
	OTHER:	

pH____________ Temperature__________(C) Dissolved Oxygen__________(mg/L) Specific Conductivity__________(mS/cm)

Ferrous Iron___________(mg/L) Oxidation/Reduction Potential___________(mv) Turbidity______________(NTU

GENERAL INFORMATION

WEATHER: SUN/CLEAR_________OVERCAST/RAIN___________WIND DIRECTION___________AMBIENT TEMPERATURE ___________

SHIPMENT VIA: FEDEX_______HAND DELIVER_________COURIER_________OTHER __________

SHIPPED TO:____

COMMENTS: ____

SAMPLER:____OBSERVER: _________________________________

MATRIX TYPE CODES		SAMPLE COLLECTION METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	HA=HAND AUGER
WG=GROUND WATER	SO=SOIL	BP=GAS OPERATED BLADDER PUMP	HY=HYDRASLEEVE
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	NS=NON-SUBMERSIBLE PUMP
SH=HAZRDOUS SOLID WASTE	WS=SURFACE WATER	EC/TC=ENCORE/TERRA CORE SAMPLER	PP=PERISTALTIC PUMP
SE=SEDIMENT	SW=SWAB/WIPE	GB=GEOPROBE	SP=SUBMERSIBLE PUMP
W=WATER		H=HOLLOW STEM AUGER	SS=SPLIT SPOON
		OTHER G = GRAB	TR=TROWEL

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SOP 403.06, SIB Project Area, PHSS
(Source: Surface and Shallow Depth Soil Sampling)

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Surface and Shallow Depth Soil Sampling	SOP No.: 403.06 (formerly 2.13)
	SOP Category: Environmental Services
	Revision No.: 3
	Revision Date: June 24, 2020
	Review Date: June 2022

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the equipment and operations used for sampling surface and shallow depth soils. This procedure outlines the methods for soil sampling with routine field operations on environmental projects.

2.0 SCOPE AND APPLICATIONS

The objective of surface and shallow depth soil sampling is to ascertain the nature and extent of soil contamination at a site. The data can be used to identify contaminant sources, evaluate potential threats to human health or the environment, evaluate potential exposure pathways, or calculate environmental risks. For the purposes of this SOP, soil is defined as all unconsolidated materials above bedrock; surface soils are those that occur 0 to 6 inches below ground surface; and shallow depth soils are soils located above the bedrock surface and from 6 inches to 2 feet below ground surface.

3.0 GENERAL REQUIREMENTS

All work is performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements must be documented sufficiently to re-create the modified process.

4.0 PROCEDURES

4.1 SAMPLING EQUIPMENT

Typically, equipment required for surface and shallow depth soil should be specified in the project field sampling plan or work plan. Equipment includes the following:

- Stainless steel mixing bowl,
- Stainless steel trowels or spoons,
- Stainless steel hand auger,
- Stainless steel core sampler that uses stainless steel or Lexan® liners (optional),
- Stainless steel shovel, and
- Appropriate sample containers.

Disposable sampling equipment items, such as a sampling spoon, may be used instead of stainless steel equipment. An example of a hand auger is provided in Attachment 1.

4.2 DECONTAMINATION

Before initial use, and after each subsequent use, all nondedicated or nondisposable sampling equipment must be decontaminated using the procedures outlined in HGL SOP 411.02: *Sampling Equipment Cleaning and Decontamination.*

4.3 SAMPLING LOCATION/SITE SELECTION

Follow the sample design criteria outlined in the project plan for each sampling event. Relocate the sample sites when conditions dictate, such as when natural or artificial obstructions are present at the proposed sample location (such as boulders or asphalt). Document the actual sample locations on a topographic map or site sketch and photograph all sample locations. GPS coordinates for the new location may also need to be recorded.

4.4 GENERAL

All boreholes and pits are filled in with the material removed during sampling unless otherwise specified in the project-specific planning documents. Where a vegetative turf has been established, fill in with native soil or potting soil and replace the turf if practical in all holes or trenches when sampling is completed.

4.4.1 Homogenizing Samples

Homogenizing is the mixing of a sample to provide a uniform distribution of the contaminants. Proper homogenization ensures that the containerized samples are representative of the total soil sample collected. All samples to be composited or split should be homogenized after all aliquots have been combined. **Do not homogenize (mix or stir) samples for volatile compound analysis. Follow the procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection* for collection of such samples.**

4.4.2 Compositing Samples

Compositing is the process of physically combining and homogenizing several individual soil aliquots of the same volume or weight. Compositing samples provide an average concentration of contaminants over a certain number of sampling points. Refer to HGL SOP 403.03: *Soil or Sediment Sample Compositing*.

4.4.3 Splitting Samples

Splitting samples is performed when multiple portions of the same samples must be analyzed separately. After preparation, fill the sample containers for the same analyses one after another in a consistent manner (parent sample for semivolatile organic compounds [SVOCs] analysis, then split sample for SVOC analysis; parent sample for total metals analysis, then split sample for total metals analysis; and so forth).

4.5 SURFACE SOIL SAMPLING

Perform the following steps for surface soil sampling:

- Before sampling, remove leaves, grass, and surface debris from the area using a decontaminated stainless steel trowel or disposable sampling spoon.
- Label the lid of the sample container with an indelible pen or affix the sample label to the side of the jar. Tape over the label to seal out dirt and water before filling the container with soil, if possible.
- Collect surface soil samples with a decontaminated stainless steel trowel, spoon, or hand auger and transfer them to a decontaminated stainless steel bowl for homogenizing. If VOC analyses are to be conducted, collect the VOC sample first following the procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection*, then transfer the appropriate aliquot of soil to the decontaminated stainless steel bowl for homogenizing.
- Collect samples in the order of volatilization sensitivity. The most common collection order is as follows:
    - VOC,
    - Purgeable organic carbon,
    - Purgeable organic halogens,
    - Total organic halogens,
    - Total organic carbon,
    - Extractable organics,
    - Total metals,
    - Phenols,
    - Cyanide, and
    - Radionuclides.
- Immediately transfer the sample into a container appropriate to the analysis being performed.
- Place the samples in a cooler with ice. The temperature in the cooler must be maintained at approximately 4ºC (if appropriate for analyses) for transport to an analytical laboratory.
- Material removed to collect the samples is returned to the boreholes and pits. Excess soil sample media should be treated as investigation-derived waste (IDW) and managed in accordance with the project-specific planning documents.
- Decontaminate all sampling equipment following HGL SOP 411.02, *Sampling Equipment Cleaning and Decontamination*.

4.6 SURFACE SOIL SAMPLING (COMPOSITE SAMPLES ONLY)

Perform the following steps for surface soil (composite) sampling:

- Before sampling, remove leaves, grass, and surface debris from the area using a decontaminated stainless steel trowel.
- Collect surface soil aliquots with a decontaminated stainless steel spoon, trowel, or hand auger and place them in a stainless steel bowl and homogenize. Homogenize the sample in accordance with HGL SOP 403.03: *Soil or Sediment Sample Compositing*. Follow the procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection*, for samples collected for VOC analysis.
- Label the sample container and place it in a cooler chilled to 4ºC . Complete the chain of custody record and pack it in the sample cooler.
- Material removed to collect the samples is returned to the boreholes and pits. Excess soil sample media IDW should be managed in accordance with the project-specific planning documents.
- Decontaminate all nondedicated sampling equipment following HGL SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

4.7 SHALLOW DEPTH SOIL SAMPLING

Perform the following steps to collect shallow depth soil samples:

- Use a decontaminated stainless steel shovel to remove the top layer of soil and leaves, grass, and surface debris.
- Excavate soil to the pre-determined sampling depth using a decontaminated hand auger. Periodically remove the cuttings from the auger.
- When the proper sample depth is reached, remove the hand auger and all cuttings from the hole.
- Lower the decontaminated core sampler or hand auger to the bottom of the hole. When using a core sampler, it must contain a decontaminated liner appropriate for the constituents to be analyzed.
- Mark the sample interval on the hammer stem or auger.
- Operate the slide hammer on the core sampler to drive the sampler head into the soil, or advance the auger until it is flush with the interval mark at ground level.
- Record weight of hammer, length of slide, blow counts, and geologic soil data for all samples collected with a core sampler in the field logbook as outlined in HGL SOP

300.04: *Field Logbook Use and Maintenance*. This information may also be entered on Attachment 2, Surface and Shallow Soil Sampling Log.

- When the core sampler liner or auger has been advanced to the total depth of the required sample, remove it from the bottom of the hole.
- Immediately remove the liner from the core sampler and transfer the sample into a container or stainless steel bowl appropriate to the analysis being performed and then composite and homogenize it in accordance with HGL SOP 403.03: *Soil or Sediment Sample Compositing*. For VOC analysis follow the sample procedures outlined in HGL SOP 403.01: *VOC Soil Sample Collection.*
- Label the sample container and place it in a cooler chilled to 4ºC . Complete the chain of custody record and pack it in the sample cooler.
- Material removed to collect the samples is returned to the boreholes and pits. Excess soil sample media IDW should be managed in accordance with the project-specific planning documents.
- Decontaminate all sampling nondedicated equipment following HGL SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.

4.8 ABANDONMENT PROCEDURES

Abandon boreholes and fill them to grade with the material removed for sampling, if approved, or clean fill.

5.0 DOCUMENTATION

Record applicable sampling information in the field logbook as outlined in HGL SOP 300.04: *Field Logbook Use and Maintenance*. This information can also be entered on Attachment 2, Surface and Shallow Soil Sampling Log.

The project manager or an approved designee checks all field sheets and field logbooks used to record information during sampling for completeness and accuracy as soon as possible after the sampling event. Any discrepancies are noted, and the documents are returned to the originator for correction. The reviewer acknowledges that these review comments have been incorporated by signing and dating the “checked by” and “date” blanks on the field sheets and at the applicable places in the logbook.

6.0 REVISION HISTORY

Revision 0	July 2010	Initial Release
Revision 1	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	February 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	June 24, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.13 to 403.06.

ATTACHMENTS

Attachment 1 – Example of Hand Auger and Core Sampler
Attachment 2 – Surface and Shallow Soil Sampling Log

ATTACHMENT 1
EXAMPLE OF HAND AUGER AND CORE SAMPLER

AMS, Inc.
105 Harrison Street
American Falls,
Idaho 83211

800.635.7330
208.226.2017
fax: 208.226.7280
ams@ams-samplers.com
www.ams-samplers.com

The world's finest sampling equipment.

Basic Soil Sampling Kit - 5/8" Threaded

DESCRIPTION:
Hand auger kit includes a Standard type Regular, Mud and Sand Auger plus an AMS Core Sampler* with slide hammer. Included accessories are three 4 foot (1.2m) extensions, cross handle, cleaning brush, 2 crescent wrenches and slip wrench all contained in an AMS Deluxe storage and transport case. Two sizes of kit are available, 3 1/4 inch (8.3 cm) augers with 2 inch (5.1 cm) Core Sampler and 2 1/4 inch (5.7 cm) augers with 1 1/2" Core Sampler. Quick connect is not available with this kit.

APPLICATION:
Use of the augers for accessing the sampling point at depths of up to about 12 feet (3.6 m) with the supplied extensions and AMS slide hammer. The sample may be collected within a removable retaining cylinder (liner). Plastic end caps are included.

FEATURES
AMS Soil augers are designed to rapidly remove soils of all types, using the specially designed bits on the Regular, Mud, and Sand models. The auger tips are tungsten carbide hard surfaced and heat treated before sharpening. The core sampler features a heat treated coring tip on the cylinder and a threaded end cap. All attatchment couplings are 5/8 NC threaded.

BENEFITS
For your convenience, all the items necessary for accessing a sampling point and then taking a sample are included. AMS soil buckets are the most efficient available in terms of effort required and speed. The AMS Core Sampler allows immediate core examination or a sample may be collected in a retaining cylinder for later use.

USE:
Assemble the chosen soil auger with an extension and cross handle. Place at the desired angle on the soil surface and turn three revolutions, or until full. Lift carefully from the hole and empty from the bail by tapping the cross handle on the ground. Repeat until the sampling depth is reached. Assemble core sampler to an extension(s) and slide hammer. Place in the hole and mark the extension six inches (5.1 m) above the soil surface. Use the slide hammer to drive in the the sampler to the mark and carefully remove. Disassemble, remove the liner and place the cap on each end.

HELPFUL HINTS:
Use plumbers wick on 5/8 inch male threads used with Slide Hammer to help threads stay tight. Keep all fittings and samplers clean, dry and free of dirt or Mud. You can clean tooling with soapy water. Always dry to prevent rusting. Use a wire brush on male threads. Use vegetable oil on tools to prevent fittings locking up and rusting. When using augers, use rubber O-rings on male 5/8 inch thread to help take apart.

SPECIFICATIONS:
AMS Soil Auger Kits are manufactured by AMS from all USA made materials. See separate AMS Technical Data Sheets for details on the Regular, Mud, Sand & Soil Augers, Core Sampler, Extensions, Cross Handles, Slide Hammer, and Liners. Crescent wrenches are made from chrome plated forged steel. The cleaning brush is made with nylon bristles, with a twisted wire handle. The AMS Deluxe Case is molded from glass reinforced plastic with a lid gasket and lockable hasps.

Kit Composed of the Following Items

Item	Size	Part #	Size	Part#
1- Regular Auger	3 1/4"	400.06	2 1/4"	400.08
1- Mud Auger	3 1/4"	400.18	2 1/4"	400.20
1- Sand Auger	3 1/4"	400.40	2 1/4"	400.42
1- Cross Handle		406.04		406.04
3- Thrd. Extensions	4'	408.03	4'	408.03
1- Core Sampler*	2" x 6"	404.10	1 1/2" x 6	404.38
* w/slip wrench, liner & caps				
1- Slide Hammer		400.99		400.99
1- AMS Nylon Brush	2"	430.07	1 1/2"	430.11
2- Crescent Wrenches 421.10			421.10	
1- Slip Wrench		421.29		421.29
1- AMS Deluxe Case		430.01		430.01

* Patent Pending, USA & Foreign

ANCILLARY ITEMS:
AMS Extensions, Liners, End Caps, End Cap Inserts, Sieves, Soil Color Charts, and Sample Containers.

Basic Soil Sampling Kit

Basic Soil Sampling Kit

Size	Basic Kit Regular
2 1/4"	209.53
3 1/4"	209.51

ATTACHMENT 2
SURFACE AND SHALLOW SOIL SAMPLING LOG

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HGL HydroGeoLogic, Inc Exceeding Expectations	**Surface and Shallow Soil Sampling Log**	Records Management Data
Project Number	Project Name	Page ____ of _____

General Info			
	Location		
	Surface Elevation ft.	Date Started	Date Completed
	Field Investigator		C of Cr
	Sampling Excavation Method	Sampling Method	
	Depth of Excavation ft.	Depth Water First Encountered ft.	Backfill Material

Sampling Info	**Sample Number**	**Depth (ft)**	**Lithologic Description**[1]	**Sample Container**	**Analyses Requested**

Plan View		**Legend**
		Soil Sampling Location

Recorded By:	Date	Checked By:	Date:

[1] Include such data as OVM, pH, blow counts, or other physical reading observations.

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SOP 403.07, SIB Project Area, PHSS
(Source: Geologic Borehole Logging)

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Geologic Borehole Logging	**SOP No.: 403.07 (formerly 2.14)**
	SOP Category: Environmental Services
	Revision No.: 2
	Revision Date: November 20, 2019
	Review Date: November 2021

1.0 PURPOSE

This Standard Operating Procedure (SOP) defines the methodology for conducting lithologic logging of cores, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by HGL.

2.0 SCOPE AND APPLICATIONS

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. Following the guidelines presented in this SOP will help ensure that pertinent data is collected so that all borehole logs made while installing these devices at a site can be standardized to create a consistent, uniform database from which interpretive conclusions can be made with minimal decision error. A borehole log provides lithologic descriptions to characterize the physical subsurface and the geologic and hydrologic processes operating at the site. A properly prepared borehole log serves as an essential tool for evaluating and correlating these processes.

This SOP provides guidance for routine field operations on environmental projects, and was derived from *A Compendium of Superfund Field Operations Methods*, U.S. Environmental Protection Agency (EPA) (EPA/540/P-87/001 [Office of Solid Waste and Emergency Response {OSWER Directive} 9355.0-14]); and other industry standards.

3.0 GENERAL REQUIREMENTS

All work will be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

4.1 INTRODUCTION

Boreholes should be logged by a trained geologist, or other earth scientist under the supervision of a geologist. Large-scale inferences such as vertical and horizontal extent of strata, facies changes, attitude of bedding or layering, structural features (faults, folds, fractures, dikes, etc.), location of the water table, lithologic characterizations, and the extent of subsurface contamination are made from small-scale observations recorded on the borehole log. These observations include bedding, grain size, degree of sorting, shape of grains, color, hardness, organic vapor levels, and other observable physical characteristics including visible evidence of contamination.

Logging should document both general and specific lithologic information about the borehole. In all cases, the lithologic log should be identified with the following:

- Specific site number,
- Well/boring number,
- Drilling method,
- Location,
- Date of drilling,
- Individual logger (geologist),
- Drilling contractor,
- Significant organic vapor reading,
- Visible evidence of contamination, such as staining or odor,
- Depth to water first encountered,
- Final depth of water level,
- Well/boring elevation (if data is available),
- Total depth in feet,
- Graphic log, and,
- Lithologic description.

Lithologic descriptions for unconsolidated materials often use the Unified Soil Classification System (USCS) or standard geologic field description methods (Compton, 1962).

Lithologic descriptions of unconsolidated material should contain the following characteristics when possible:

- Soil or formation name,
- Gradation degree of sorting,
- Principal constituent,
- Specific descriptors for principal constituents (for example, plasticity, grain size, and shape),
- Firmness/hardness,
- Minor constituents,
- Moisture content,
- Color,
- Particle morphology, and

- Other descriptors (such as, visual evidence of contamination, specific monitoring equipment readings including photoionization detector [PID]/organic vapor analyzer [OVA] readings).

4.2 CLASSIFICATION SYSTEM

The following subsections describe in detail the parameters and descriptive terminology used to classify each sample for the borehole log.

4.2.1 Soil or Formation Name

The soil or formation name will include the major constituent(s) and may be preceded by a single-word modifier indicating the subordinate constituent. Percentages of each constituent will be used to classify the material without actually recording constituent percentage. The textural terms used to classify a soil are shown in Attachment 1, Triangular Diagram Showing Percentage of Sand, Silt, and Clay in Each Textural Class. If logging unconsolidated materials, a USCS symbol should be recorded. The USCS symbols are provided in Attachment 2, Unified Soil Classification System Table.

4.2.2 Gradation (Degree of Sorting)

Size sorting describes the extent to which grain size is uniform. The comparison chart listed in Attachment 3, Comparison Chart for Estimating Degree of Sorting, is used to describe coarse-grained soils being logged from a borehole. The USCS describes soils in terms of grading, which is the opposite of sorting. For example, a poorly graded sand (USCS classification SP) is well sorted and has a predominant grain size, and a well graded gravel (USCS classification GW) is poorly sorted and has a wide distribution of grain sizes.

4.2.3 Principal Constituent

Principal constituents recorded during borehole logging include an identification of the following unconsolidated material types in order of increasing grain size:

- Clay,
- Silt,
- Sand,
- Gravel,
- Cobbles, and
- Boulders.

If known, an identification of the potential source of the material should be made (such as alluvium, colluvium, artificial fill, or residual material).

4.2.4 Principal Constituent Descriptors

Additional descriptors for the principal material constituents may be added to the log to further delineate or accurately record subtle changes in the lithologic structure. Modifiers such as grain size, shape, and plasticity of materials (high, medium, and low plasticity). (Note: Plasticity is the property of permanently changing shape without movement on any visible fractures.)

4.2.5 Consistency/Density/Rock Hardness

The characteristics of unconsolidated material are often determined by hand or the Standard Penetration Test (SPT).

Hand testing of unconsolidated material involves pressing the thumb into the undisturbed material to determine its consistency based on the following descriptors:

Depth of Thumb Imprint	Cohesive Consistency (Clay)
Greater than 1 inch	Very soft
Approximately 1 inch	Soft
Approximately ¼ inch	Firm
Thumb will not indent soil but readily indented by fingernail	Hard
Thumbnail will not indent soil	Very hard

The SPT involves driving a split-spoon sampler into the material by dropping a 140-pound weight from a height of 30 inches. The resistance of the material is reported in the number of blows of the weight required to drive the spoon one foot and translates into the following descriptors:

Number of Blows/Foot	Cohesive Consistency (Clay)
0–2	Very soft
2–4	Soft
4–8	Medium
8–15	Stiff
15–30	Very stiff
30+	Hard

Number of Blows/Foot	Cohesive Consistency (Gravel)
0–4	Very loose
4–10	Loose
10–30	Medium dense
30–50	Dense
50+	Very Dense

Number of Blows/Foot	Rock Hardness
<20	Weathered
20–30	Firm
30–50	Medium Hard
50–80	Hard
80+	Very Hard

4.2.6 Minor Constituents

Constituents not previously described in the principal constituent description may be described as a percentage or by weight. Typically, modifiers for minor constituents conform to the following standards:

- No modifier < 5 percent,
- Slightly 5 to 12 percent,
- Moderately (add '-y' or '-ey' such as silty clay) 12 to 40 percent, or
- Very 40 to 50%.

4.2.7 Moisture Content

The terms used to describe the relative moisture content of a field soil sample are as follows:

- Dry – The sample is completely without moisture. Dry, silty sands, for example, will produce suspended particles when dropped by hand.
- Damp – Samples containing a very slight amount of water.
- Moist – Soils in this range are near the maximum water content for their maximum compactibility or density. Moist fine-grained soils with a water content greater than their plastic limit will form a ball when compressed in the hand.
- Wet – The soil samples are wet enough to produce free water upon shaking but still contain unoccupied air voids. Fine-grained soils close to the liquid limit would be termed wet.
- Saturated – Soils with no air voids. Samples placed in sample jars or bags will probably have standing water after a short period of time.

4.2.8 Plasticity

The plasticity of fine-grained soils is recorded on the borehole log. A fine-grained soil can be non-plastic or have low, medium, or high plasticity. The plasticity is measured by the ability to roll the material into a 1/8-inch-thick thread based on the following descriptors:

- Non-plastic – The thread cannot be rolled at any water content.
- Low plasticity – The thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.
- Medium plasticity - The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
- High plasticity – It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier the plastic limit.

4.2.9 Color

The color of soil and associated materials will be recorded on the borehole log. Color descriptors should include but are not limited to the following descriptors: black, gray-black, brown, olive, mottled, and streaked. A Munsell Soil Color Chart should be used to provide general logging guidance, but specific use is not necessary for adequately describing lithology.

4.2.10 Particle Morphology

The key elements of particle morphology are roundness and sphericity. Roundness is a measure of the curvature of grain corners. Sphericity is a measure of how equal the three axial lengths (x, y, z) of an object are. Determination of both properties is facilitated by the use of a hand lens. Estimate grain roundness and sphericity in coarse-grained soils by using an American Geological Institute (AGI) data sheet (Attachment 4).

4.2.11 Other Descriptors

Field screening data collected during the drilling process may help further characterize site conditions during subsurface investigations. Readings from on-site monitoring equipment such as PIDs, flame ionization detectors (FIDs), or OVAs should be recorded at each sample interval. Other useful information includes the organic content and the presence or absence of waste material in samples.

4.2.12 Particle Size Distribution

An estimate of particle sorting by grain size is often useful for borehole logging purposes. Precise estimates of percent composition of the sample are not necessary.

USCS Grain Size Categories

Exact Size Limits	Approximate Inch Equivalents	Name of Loose Aggregate
>256 mm	>10 in.	Boulder gravel
64–256 mm	2.5–10 in.	Cobble gravel
32–64 mm	1.2–2.5 in.	Very coarse pebble gravel
16–32 mm	0.6–1.2 in.	Coarse pebble gravel
8–16 mm	0.3–0.6 in.	Medium pebble gravel
4–8 mm	0.15–0.3 in.	Fine pebble gravel
2–4 mm	0.08–0.15 in.	Granule (or very fine pebble) gravel
1–2 mm	0.04–0.08 in.	Very coarse sand
1/2–1 mm	0.02–0.04 in.	Coarse sand
1/4–1/2 mm	0.01–0.02 in.	Medium sand
1/8–1/4 mm	0.005–0.01 in.	Fine sand
1/16–1/8 mm	0.002–0.005 in.	Very fine sand
1/256–1/16 mm	0.00015–0.002 in.	Silt
<1/256 mm	<0.00015 in.	Clay (clay-size materials)

mm = millimeters
Source: Wentworth Scale; Compton 1962

The Comparison Chart for Estimating Percentage Composition (Attachment 5) can be used to estimate the percentage of various grain sizes present in a sample. However, visual estimates usually provide sufficient information for characterizing site lithology.

4.3 BOREHOLE LOGS

Record data collected during exploratory boring soil logging in the field logbook and on Attachment 6, Borehole Log. Use this log on all applicable field drilling and subsurface sampling operations.

Geologic correlation and aquifer properties prediction are dependent on good exploratory boring sample descriptions. Rotary drilling with fluids is generally unacceptable since the drilling fluids may potentially contaminate the aquifer under investigation and provide inaccurate water levels. High quality borehole data are generally acquired with a direct-push acetate-lined sampler, a split-spoon sampler, or a sonic core barrel. This method of sampling provides detailed logging because the samples collected are undisturbed. The lithofacies interpreted from air-rotary or auger cuttings logs may lack the accuracy necessary for detailed correlation. Where possible, techniques such as geophysical borehole logging will be used to supplement cuttings descriptions. Note on the log any geologic description determined from borehole cuttings. The cuttings are often mixed over the entire length of the boring.

In bedrock formations, cuttings may be acquired from a reverse circulation, air rotary, or dual-wall rotary boring. These cuttings do not provide information on the in situ properties of the materials, but do provide adequate sample description information.

In summary, close sample spacing or continuous sampling in a boring provide the best material for descriptive geology. Use traditional geologic terminology and supplement with the USCS descriptive system when appropriate. Provide sufficient data on layering and other sedimentary structures and undisturbed textures. Sample numbers, depths, and analytes should be included in each description. The applicable field methods described by Compton (1962) and AGI (1982) are recommended. These methods are fully referenced in Section 5.0.

4.4 REVIEW

Personnel conducting borehole logging of soil will record field data on Attachment 6, Borehole Log, and will record a chronological summary in the project logbook. The applicable methods outlined in this procedure shall be used to record the data on this log. The personnel conducting these operations will sign and date the “logged by” and “date” blanks on Attachment 6, Borehole Log.

The Project Manager or designee shall check all field generated data and Attachment 6, Borehole Log, for completeness and accuracy. Any discrepancies will be noted, and the logs will be returned to the originator for correction. The reviewer will acknowledge that corrections have been incorporated by signing and dating the “reviewed by” and “date” blanks on Attachment 6, Borehole Log.

5.0 REFERENCES

American Geological Institute (AGI), 1982. AGI Data Sheets. Falls Church, Virginia.

ASTM International, 2009. ASTM D2488-09a: *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. West Conshohocken, Pennsylvania.

Compton, Robert R., 1962. *Manual of Field Geology*. John Wiley and Sons, Inc. New York, New York.

Munsell, 1988. Munsell Soil Color Charts. Macbeth Division, Kollmorgen Instruments Corporation, Baltimore, Maryland.

6.0 REVISION HISTORY

Revision 0	December 2010	Initial Release
Revision 1	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	November 20, 2019	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.

ATTACHMENTS

Attachment 1 – Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class
Attachment 2 – Unified Soil Classification System Table
Attachment 3 – Comparison Chart for Estimating Degree of Sorting
Attachment 4 – Comparison Chart for Estimating Roundness and Sphericity
Attachment 5 – Comparison Chart for Estimating Percentage Composition
Attachment 6 – Borehole Log

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ATTACHMENT 1

TRIANGULAR DIAGRAM SHOWING PERCENTAGE OF SAND, SILT AND CLAY IN EACH TEXTURAL CLASS

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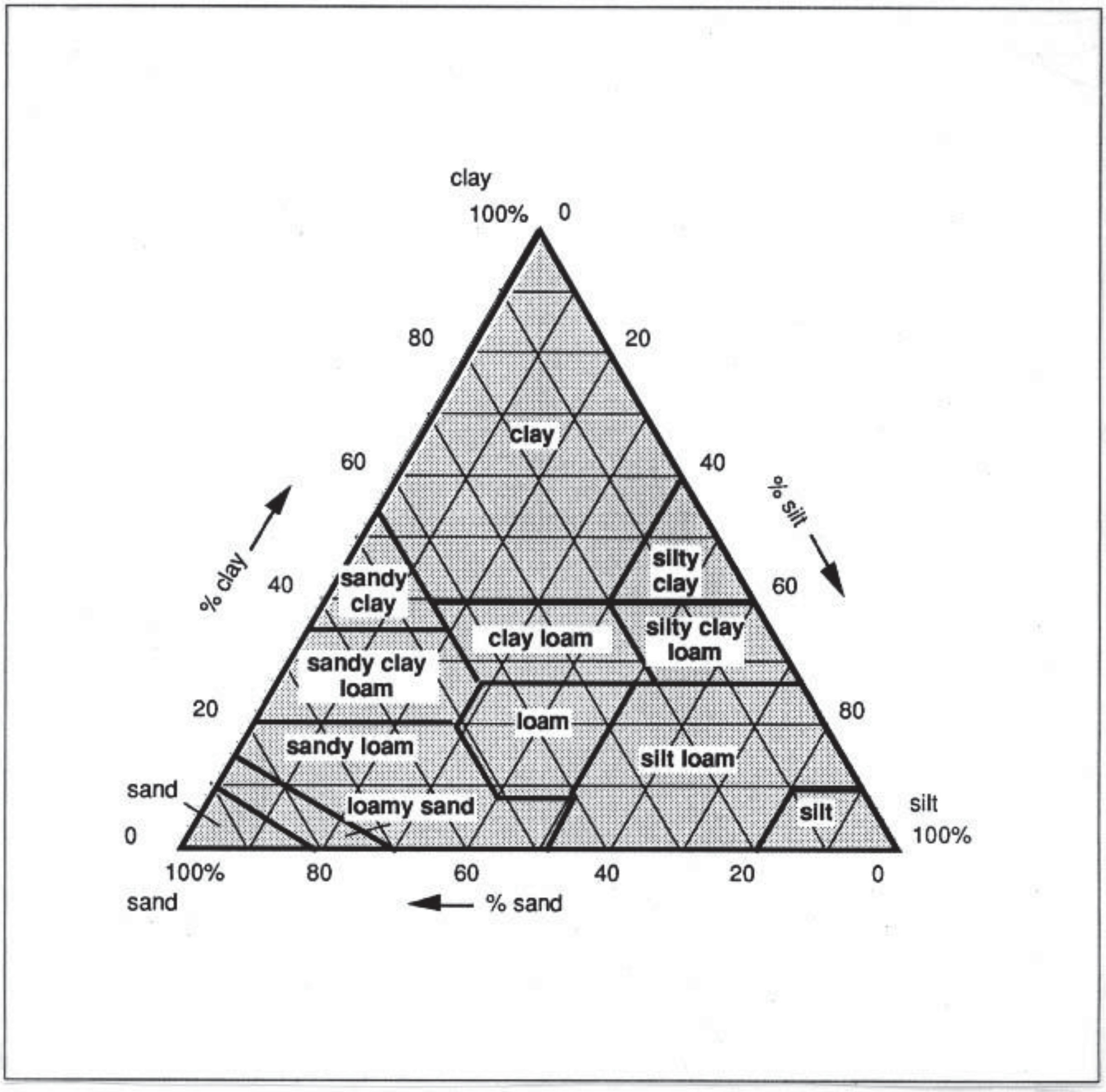
Attachment 1
Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class



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ATTACHMENT 2

UNIFIED SOIL CLASSIFICATION SYSTEM TABLE

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Attachment 2
Unified Soil Classification System Table

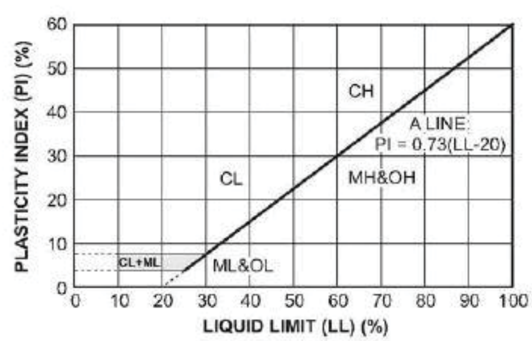
UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART		
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
	Clean Gravels (Less than 5% fines)	
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
	Clean Sands (Less than 5% fines)	
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

LABORATORY CLASSIFICATION CRITERIA		
GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



ATTACHMENT 3

COMPARISON CHART FOR ESTIMATING DEGREE OF SORTING

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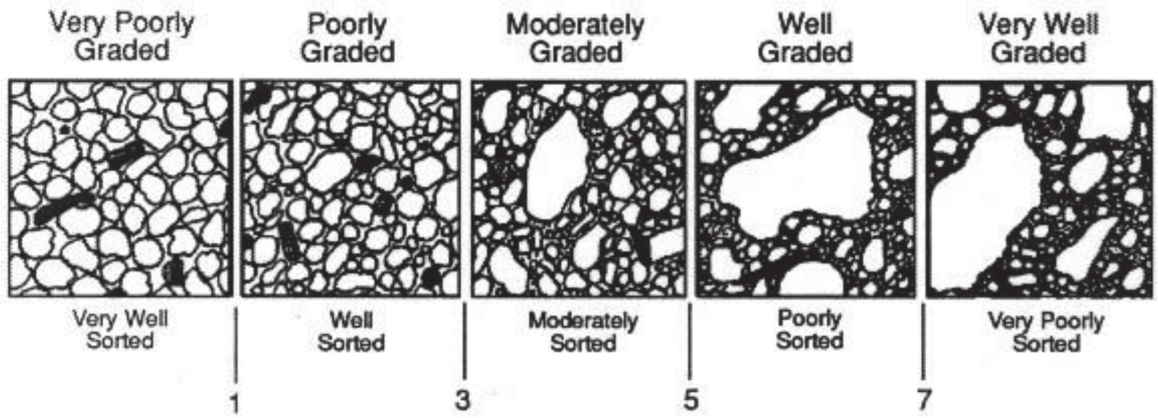
Attachment 3
Comparison Chart for Estimating Degree of Sorting



Terms for degrees of sorting. The numbers indicate the number of size-classes included by the bulk (80 percent) of the material. The drawings represent sandstones as seen with a hand lens. Silt and clay-size materials are shown diagrammatically by the fine stipple.

Reference: Compton, R.R. 1962. ***Manual of Geology.*** **John Wiley & Sons, Inc. New York, N p. 214**

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ATTACHMENT 4

COMPARISON CHART FOR ESTIMATING ROUNDNESS AND SPHERICITY

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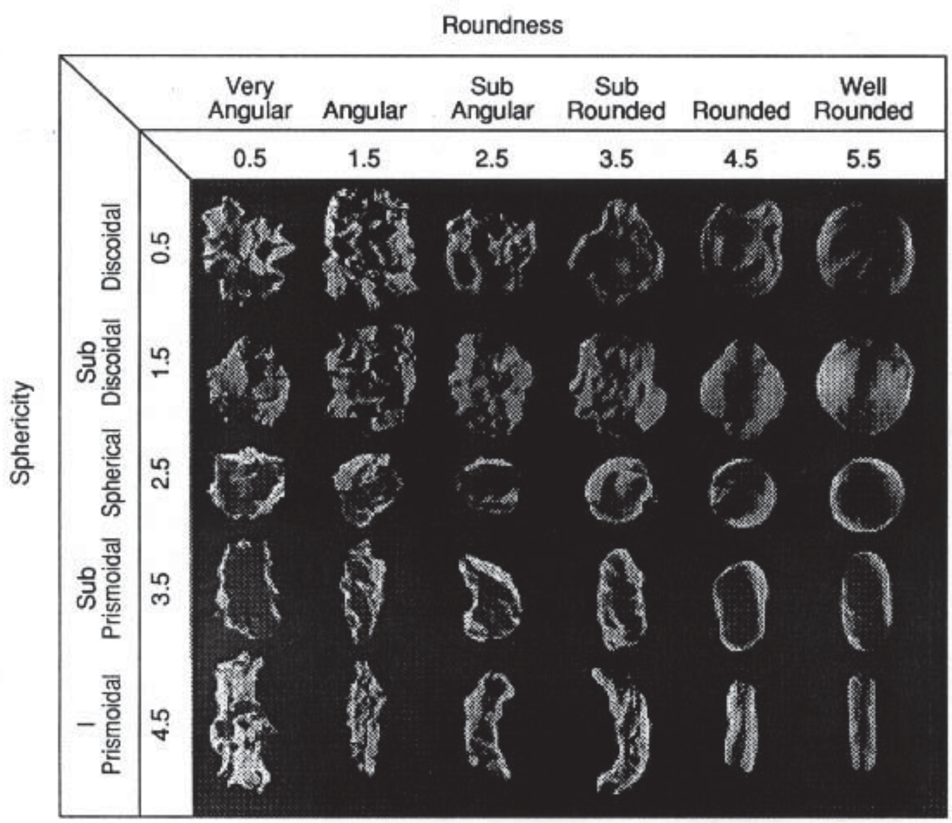
Attachment 4
Comparison Chart for Estimating Roundness and Sphericity



Reference: American Geological Institute. 1982. "AGI Data Sheet 18.1" in *AGI Data Sheets*. Fall Church, VA

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ATTACHMENT 5

COMPARISON CHART FOR ESTIMATING PERCENTAGE COMPOSITION

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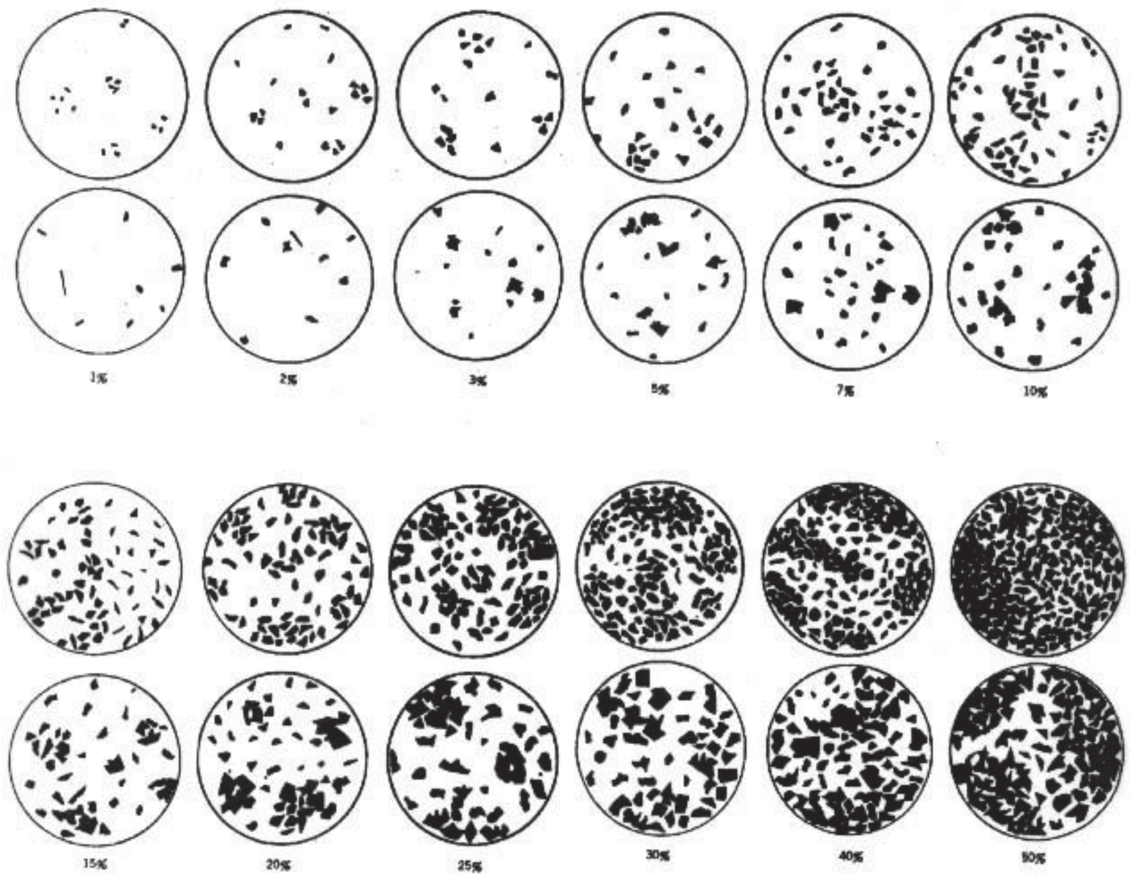
Attachment 5
Comparison Chart for Estimating Percentage Composition



Reference: Compton, R.R. 1962. *Manual of Geology*. John Wiley & Sons, Inc. New York, NY p. 332-333

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ATTACHMENT 6

BOREHOLE LOG

Attachment 6
Borehole Log

BORING LOG

Borehole ID: __________
Sheet _____ of ____

Project Name	Project Number	Site ID	Location
Drilling Company	Driller	Ground Elevation	Total Drilled Depth
Drilling Equipment / Drilling Method / Borehole Diameter		Date/Time Drilling Started	Date/Time Total Depth Reached
Type of Sampling Device		Water Level (bgs) First Final	
Sample Hammer Type Driving Wt. Drop		Hydrogeologist	Checked by/Date
Location Description (include sketch in field logbook)			

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

HGL HydroGeoLogic, Inc

BORING LOG (cont'd)

Borehole ID: _________
Sheet _____ of ____

Project Name	Project Number	Location
Location Description (include sketch in field logbook)		

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

SOP 403.08, SIB Project Area, PHSS
(Source: Sediment Sampling)

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Sediment Sampling	SOP No.: 403.08 (formerly 2.15)
	SOP Category: Environmental Services
	Revision No.: 2
	Revision Date: March 25, 2020
	Review Date: March 2022

1.0 PURPOSE

This standard operating procedure (SOP) establishes the guidelines for sediment sampling using a variety of sampling devices. Methods for preventing sample and equipment cross-contamination are included. Proper sediment sampling ensures that any evaluations of sediment contamination are based on actual contaminant levels and are not based on improper sampling techniques.

This SOP provides guidance for routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the HGL project manager.

2.0 SCOPE AND APPLICATIONS

Field personnel collecting sediment samples are responsible for performing the applicable tasks outlined in this procedure when conducting work related to environmental projects.

The project manager or an approved designee is responsible for checking all work performed and verifying that the work satisfies the applicable tasks required by this procedure. This verification will be accomplished by reviewing all documents and data produced during work performance.

3.0 GENERAL REQUIREMENTS

All work will be performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and documented in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 SAMPLING EQUIPMENT AND TECHNIQUES

Sediment samples may be obtained using on-shore or off-shore techniques. Sediment sampling equipment and techniques must be designed to minimize the risk of dilution or loss of material as the sample is moved through the water column. Sediment sampling devices are described below.

4.1 DIP SAMPLERS

A dip sampler consists of a pole with a jar or scoop attached. The pole may be made of bamboo, wood, Teflon®, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is attached by a clamp.

The dip sampler is operated by submerging the jar or scoop and pulling it through the sediments to be sampled. The samples retrieved are then transferred into the appropriate sample container after decanting the liquid. Further decanting can occur while the sample is present in the sample jar. Avoid contact with sampler's gloves. Transferring the sample may require the use of a stainless steel or Teflon® spoon/spatula.

4.2 HAND-OPERATED CORE SAMPLERS

Hand-operated sediment core samplers are used to obtain sediment samples in shallow water (less than 3 feet). These samplers operate in a manner similar to soil core samplers. However, because of the saturated conditions of most sediments, provisions must be made to retain the sample within the core. Core samplers are generally constructed of a rigid metal outer tube into which a 2-inch plastic core sleeve fits with minimum clearance. The cutting edge of the core sampler has a recessed lip on which the plastic sleeve rests and that can accommodate a core retainer. This retainer is oriented such that when the sampler is pressed into the sediment, the core is free to move past the retainer. Due to construction of the retainer, the core will not fall through the retainer upon removal of the sampler from the sediment. Some core samplers are also equipped with a butterfly valve below the core barrel that helps retain the material when the sampler is removed from the sediment.

After the sampler has been removed from the sediment, the plastic sleeve is removed. The sediment is removed from the sleeve and placed in the appropriate sample container. Chlorinated organics will not be collected using core samplers because core sleeves and retainers are generally made of plastic. The hand-operated core sampler will not be useful for obtaining samples of gravelly, stony, or consolidated sediments. Examples of hand-operated core samplers are referenced in Attachment 1.

4.3 GRAVITY CORE SAMPLERS

Gravity core samplers are used to obtain sediment samples in water bodies or lagoons with depths greater than 3 to 5 feet. These types of samplers can be used for collecting 1- to 2-foot cores of surface sediments at depths of up to 100 feet beneath the water surface.

As with all core-type samplers, gravity core samplers are not suitable for obtaining samples of coarse, gravelly, stony, or consolidated deposits. They are, however, useful for fine-grained inorganic sediment sampling.

The gravity core sampler operates in a manner similar to the hand-operated core in that a 2-inch plastic sleeve fits within a metal core housing fitted with a cutting edge. Plastic nests are used to retain the core within the plastic sleeve. An opening exists above the core sleeve to allow free flow of water into and through the core as it moves vertically downward to the sediment. The sampler has a field personnel-operated, messenger-activated valve assembly that seals the opening above the plastic sleeve following sediment penetration. This valve is activated by the messenger, creating a partial vacuum to assist in sample retention during retrieval.

Samples are obtained by allowing the sampler, which is attached to approximately 100 feet of stainless steel aircraft cable, to drop to the benthic deposits. The weight of the sampler drives the core into the sediment to varying depths depending on the characteristics of the sediments. The messenger is then dropped by field personnel on the taut aircraft cable to seal the opening above the plastic sleeve. The sampler is then carefully retrieved.

Upon retrieval of the sampler, the plastic core sleeve is removed and the sample is placed in the appropriate sample container. Care should be exercised in labeling to properly identify sample orientation. Examples of gravity core samplers are referenced in Attachment 2.

4.4 DREDGES

Dredges are generally used to sample sediments that cannot easily be obtained using coring devices or when large quantities of materials are required. Various dredge designs are available for sampling in deep or turbulent waters and for obtaining samples from gravelly, stony, or dense deposits.

Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Dredges are commonly quite heavy and may require use of a winch and crane assembly for sample retrieval.

Upon retrieval of the dredge, the sample can either be sieved or transferred directly to a sample container for labeling and storage. Examples of dredge types that could be used for sampling include Ponar, Petersen, and Ekman dredges, which are referenced in Attachment 3.

4.5 HAND AUGERS

Sediment samples may be collected using a hand auger. When using a hand auger, provisions must be made to ensure that sediment samples remain in the auger. Hand augers are best utilized when sampling non-subaqueous sediments. Additional information on hand augers can be found in SOP 403.06: *Surface and Shallow Depth Soil Sampling.*

5.0 PROCEDURES

5.1 SAMPLING SEDIMENT WITH NO OVERLYING SURFACE WATER

Sediment samples obtained from areas with no overlying surface water will be collected in accordance with the following procedures:

- Record all data in the field logbooks in accordance with SOP 300.04: *Field Logbook Use and Maintenance.*

- Insert a decontaminated Teflon® or stainless steel spoon, scoop, or trowel into the sediment to the desired depth and remove the collected sample, or rotate and push down a decontaminated hand auger into the sediment to the desired depth and remove the collected sample. A disposable scoop may be used for specified media and analytical parameters in accordance with the site-specific project plans.
- Collect samples for volatile organic compounds (VOC) analyses, if applicable, from the sampling device or from unmixed sediment placed into a stainless steel bowl in accordance with SOP 403.01: *VOC Soil Sample Collection*.
- Place the sample in a decontaminated stainless steel bowl. Stir the sample thoroughly (non-VOC samples only) with a decontaminated stainless steel spoon or spatula—or with a dedicated disposable scoop—to provide a homogeneous mixture before filling sampling containers.
- Follow the guidelines in the site-specific project plans and Quality Assurance Project Plan (QAPP) for aliquot size (mass), container type, storage conditions, and holding times. [Note: When sampling in coarse materials, such as gravel, discretion must be used to limit inclusion of large sediment particles. As the analysis of sediments performed by the laboratory is typically restricted to particles less than 2 millimeters in size, care must be taken to ensure that there is sufficient sample volume consisting of particles smaller than 2 millimeters. As a general rule, particles larger than 0.5 inch (12.7 millimeters) in size should be excluded unless a grain size analysis is planned.] Fill the appropriate sample containers as detailed in the site-specific project plans. Identify or label samples carefully and clearly, addressing all the categories or parameters.
- Label the sample containers and place the filled sample containers on ice immediately.
- Decontaminate the sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.
- Complete all chain of custody documents and record information in the Field Sampling Report (Attachment 4) and the field logbook (see the project-specific QAPP for sample custody procedures).

5.2 SHALLOW STREAM SEDIMENT SAMPLING

Stream sediment sampling within shallow (less than 2 feet) water will be conducted in accordance with the following procedures. Note that if co-located surface water samples are being collected, the surface water sample should be collected first.

- Collect the sample in an area of sediment accumulation, such as the inside of stream meanders, quiet shallow areas, and low-velocity zones. Avoid areas of net erosion, such as high-velocity, turbulent flow zones.

- If possible, collect the sample while remaining on the stream bank. If the sample cannot be obtained from the bank, enter the stream from a point downstream of the sediment sampling location. Consult the site health and safety plan before entering the river to avoid potential hazards. Collect the sediment sample by reaching into the stream with a decontaminated stainless steel spoon or Teflon® scoop and scooping a sample in an upstream direction. Attempt to minimize the loss of fine material. A disposable scoop may be used for specified media and analytical parameters, in accordance with the site-specific project plans.
- Collect samples for VOC analyses, if applicable, from the sampling device or from unmixed sediment placed into a stainless steel bowl in accordance with SOP 403.01: *VOC Soil Sample Collection*.
- Place sample in a stainless steel bowl and gently mix with a stainless steel spoon or dedicated disposable scoop (non-VOC samples only). Transfer the sediment samples to the appropriate sample containers using the stainless steel spoon or dedicated disposable scoop. Do not mix samples for volatile organic analyses.
- Follow the guidelines in the site-specific project plans and QAPP for aliquot size (mass), container type, storage conditions, and holding times. See note under Section 5.1 for sampling coarse materials. Fill the appropriate sample containers as detailed in the site-specific project plans. Identify or label samples carefully and clearly, addressing all the categories or parameters.
- Decontaminate the sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.
- Complete all chain of custody documents and record information in the Field Sampling Report (Attachment 4) and the field logbook (see the project-specific QAPP for sample custody procedures).

5.3 SUBAQUEOUS SEDIMENT SAMPLING

Subaqueous sediment sampling from lakes, ponds, lagoons, and surface impoundments will consist of the following:

- Select the most appropriate sediment sampling device (as described in Section 4.0).
- Decontaminate all sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination*.
- If sampling from a boat equipped with an engine, attempt to collect the sample with the boat engine off or attempt to ensure that all exhaust fumes are directed away from the sample collection area until the sample has been collected.

- Lower the sampler at a controlled descent of approximately 1 foot per second until the sampler reaches the sediment surface, as indicated by a slackening of the cable. Release the weighted messenger, if applicable, to engage the closing mechanism of the dredge. Slowly retrieve the sampler and raise it at a controlled speed. When the sampler is at the water surface, attach a tag line(s) to steady and pull the sampler back into the boat. If large samplers are used, a motorized winch may be required for retrieval.
- Open and tie back any vent flaps on the sampler and carefully siphon off any overlying water, disposing of it over the side of the boat.
- Visually inspect the sample for acceptability (for example, determine if an undisturbed surface layer is evident, the overlying water is not excessively turbid, and adequate penetration is achieved). If the sample is not acceptable, discard it and collect another sample from an adjacent and upstream location.
- Carefully extrude the sediment from the sampler by slowly lifting on the winch cable and sliding the sample out the bottom of the sampler. If using core liners, remove the front face of the core liner to expose the side of the core.
- Visually inspect the side of the sample to identify any obvious stratification (such as different sediment types, sizes, or colors). If no patterns are evident, collect a sample from the surface and mid-core depth. During some investigations, it may be necessary to collect separate samples from the surface and mid-core depths. This may best be accomplished by gently scraping the side of the core with a decontaminated stainless steel scraper or knife. Scrape from the bottom to the top of the core only. If the sediment is unconsolidated, do not scrape.
- Remove the upper 2 centimeters of the sample using a decontaminated Teflon® or stainless steel scoop—or dedicated disposable scoop—and place it in the sample container. From an undisturbed area of the sample surface, scoop a 2-centimeter sample only if grain size analysis is required. After grain size analysis samples are collected, scrape off the upper sediment layer and discard it overboard. Collect samples from the mid-section of the sediment. Sediment must be removed with caution to avoid cross-contaminating the sample (that is, from exposure to engine exhaust, rust, or grease).
- Do not include nonrepresentative materials, such as twigs or debris, in the sample. Do not include sediments that have come into contact with the side of the sampler or core liner for analysis.
- Follow the guidelines in the site-specific project plans and QAPP for aliquot size (mass), container type, storage conditions, and holding times. Fill the appropriate sample containers as detailed in the site-specific project plans. Identify or label samples carefully and clearly, addressing all the categories or parameters;
- Decontaminate the sampling equipment in accordance with SOP 411.02: *Sampling Equipment Cleaning and Decontamination* after use and between sampling if dedicated

disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.

- Complete all chain of custody documents and record information in the Field Sampling Report (Attachment 4) and the field logbook (see the project-specific QAPP for sample custody procedures).

6.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements detailed in the project-specific planning documents. The field logbook will be completed in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance.* A Field Sampling Report will be filled out for each sediment sample collected (Attachment 4).

7.0 REVISION HISTORY

Revision 0	December 2010	Initial Release
Revision 1	August 11, 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	February 25, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.15 to 403.08.

ATTACHMENTS

Attachment 1 – Core Sampler
Attachment 2 – Gravity Core Sampler
Attachment 3 – Dredges
Attachment 4 – Field Sampling Report

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ATTACHMENT 1
CORE SAMPLER

CORE SAMPLER

AMS Core Sampler (http://www.ams-samplers.com/hand-tooling/sludge-and-sediment-samplers/sludge-and-sediment-samplers/sludge-and-sediment-samplers.html)

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ATTACHMENT 2
GRAVITY CORE SAMPLER

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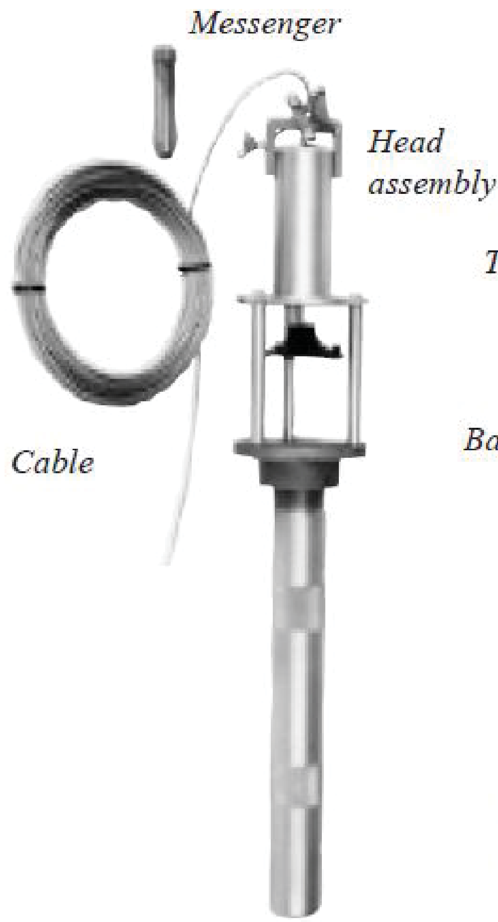
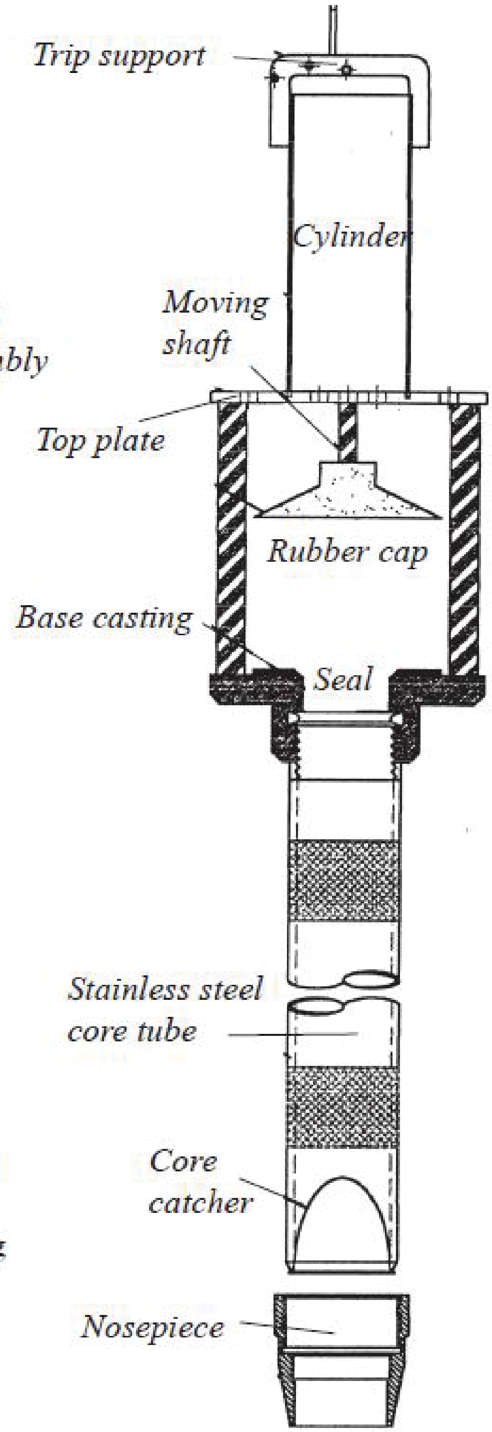
K-B GRAVITY CORER





The K-B™ (Kajak-Brinkhurst) corer is recommended by Standard Methods for obtaining estimates of the standing stock of benthic macroinvertebrates inhabiting soft sediments.

Wildco K-B Corer (http://shop.sciencefirst.com/wildco/k-b-corers/7815-k-b-corer.html)

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ATTACHMENT 3
DREDGES

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PONAR

WILDCO Ponar Dredge (http://www.benmeadows.com/wildco-ponar-grabs_36816477/)

PETERSON

WILDCO Peterson Dredge (https://www.coleparmer.com/p/mn/7270)

EKMAN

EKMAN Dredge (http://www.benmeadows.com/ekman-bottom-grab-sampler_36816471/?searchterm=ekman%2bdredge)

ATTACHMENT 4
FIELD SAMPLING REPORT

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HGL HydroGeoLogic, Inc

FIELD SAMPLING REPORT

LOCATION: ______________________ PROJECT : ________________________

SITE: ____________________________

SAMPLE INFORMATION

MATRIX ________________________ SAMPLE ID: _______________________

SAMPLING METHOD ______________ DUP./REP. OF : ____________________

BEGINNING DEPTH ______________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE YES ( ) NO ( )

END DEPTH _____________________

GRAB ( ) COMPOSITE ( ) DATE: ____________ TIME: __________

CONTAINER SIZE/TYPE	#	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH ______ Temperature ________ Dissolved oxygen __________ Specific Conductivity__________

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DRIECTION _______ AMBIENT TEMP ______

SHIPMENT VIA: FEDEX _____ HAND DELIVER ______ COURIER _______ OTHER _______

SHIPPED TO: ____

COMMENTS: ____

SAMPLER: ____________________________ OBSERVER: ______________________________

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAP\WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB\WIPE	SP=SUBMERSIBLE PUMP

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SOP 411.02, SIB Project Area, PHSS
(Source: Sampling Equipment Cleaning and Decontamination)

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Sampling Equipment Cleaning and Decontamination	**SOP No.: 411.02 (formerly 2.01)**
	SOP Category: Environmental Services
	Revision No.: 5
	Revision Date: June 18, 2020
	Review Date: June 2022

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe field methods to be used for cleaning and decontaminating sampling equipment.

This procedure is specifically applicable to sampling equipment that has been used to collect environmental samples or could have been exposed to contamination that could affect worker safety and/or the integrity of the analytical results of the media sampled.

Other decontamination procedures may apply to a specific project; refer to the project-specific planning documents for project-specific decontamination methods and schedules.

Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements are documented sufficiently to re-create the modified process.

2.0 SUMMARY OF THE METHOD

This SOP describes the procedures to be followed to achieve effective decontamination as follows: (1) remove contaminants from contaminated surfaces, (2) minimize the spread of contamination to uncontaminated surfaces, (3) avoid any cross-contamination of samples, and (4) minimize personnel exposures. The intent is to accomplish the required level of decontamination while minimizing the generation of additional solid and liquid waste.

3.0 DEFINITIONS

ASTM Type II Water: This is the type of deionized reagent grade water, as defined by ASTM International, used in the final rinse of surfaces of contaminated equipment.

Equipment: Equipment comprises those items (variously referred to as “field equipment” or “sampling equipment”) that are necessary to conduct sampling activities but that do not directly contact the samples.

Laboratory Detergent: This is a standard brand of phosphate-free laboratory detergent such as Liquinox® or Luminox®. Liquinox® is a traditional anionic laboratory detergent used for general cleaning and when there is concern that harsher cleaners could affect the stability of the sampling equipment. Luminox® is a specialized detergent that can remove oils and organic contamination. It may be used in lieu of a solvent rinse step in cleaning equipment for trace contaminant sampling.

Where not specified in these procedures, either detergent is acceptable. The project-specific plans should indicate if Luminox® use is acceptable.

Organic-free Water: This is tap water that has been treated with activated carbon and deionizing units. At a minimum, the finished water must meet the analytical criteria of deionized water, and it should contain no detectable pesticides, herbicides, or extractable organic compounds and no volatile organic compounds above minimum detectable levels for a given set of analyses. Organic-free water obtained by other methods is acceptable as long as it meets the above analytical criteria.

Potable/Tap Water: Potable/tap water is provided by local city sources and is safe for consumption. Chemical analysis of the water source is not required before it is used. Deionized water or organic-free water may be substituted for tap water.

Sampling Devices: This is equipment used to acquire samples.

4.0 GENERAL REQUIREMENTS

All work is performed in accordance with the project-specific planning documents. Refer to the project-specific health and safety plan for relevant health and safety requirements. Any deviations from specified requirements must be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements are documented sufficiently to re-create the modified process.

5.0 EQUIPMENT AND SUPPLIES

The following equipment is specific to decontamination requirements and does not include required safety equipment and field documentation described in the site-specific plans. Project-specific plans should be consulted for any additional equipment or deviations from the list below:

- Laboratory detergent,
- Brushes (not wire wound),
- Paper towels/rags,
- Squirt bottles (one for each decontamination fluid),
- 5-gallon buckets or decontamination pad/kiddie pool to contain decontamination fluids,
- Potable water,
- Deionized water,
- Drums or containers for decontamination fluids/solids,
- Drum/container waste labels,
- Sampling containers for decontamination fluid/solid sampling,
- Aluminum foil,
- Steam cleaner, and
- Generator and fuel.

6.0 PROCEDURAL STEPS

Decontamination of sampling devices is performed in a designated decontamination area, removed from any sampling or dedicated office location. This designated area must be in a location free of direct exposure to airborne and radiological surface contaminants and upwind of any field activities that could jeopardize the decontamination procedures or cross contaminate the cleaned equipment.

6.1 GENERAL

The following general rules are followed for decontamination operations:

- Contaminated or dirty sampling devices/equipment should not be stored with or above clean (decontaminated) sampling devices/equipment.
- Clean, decontaminated sampling devices should be segregated from all other equipment and supplies.
- Paint or any other coatings must be removed from any part of a sampling device that may either contact a sample or may otherwise affect sample integrity. After such coatings are removed, the sampling device must be decontaminated using the appropriate method.
- For any of the specific decontamination methods that may be used, the substitution of higher-grade water is permitted (for example, using deionized water in place of tap water). However, deionized water is less effective than tap water in rinsing away detergent during the initial rinse.
- Decontaminated sampling devices and all filled and empty sample containers are stored in locations protected from exposure to any contaminant.
- The method for decontaminating sampling devices and the exterior of sample containers that have been exposed to radioactive material is based on the material contaminated, the sample medium, the radiation levels, and the specific radionuclides to be removed.
- The release of decontaminated sampling devices and sample containers for unrestricted use is based on site-specific criteria. These site-specific criteria should be detailed in the project-specific plans.
- Rags/paper towels used during decontamination activities may become a hazardous waste and require segregation. Refer to the project-specific plans for hazardous waste disposal requirements.
- Sampling devices must be decontaminated before being used in the field to prevent potential cross-contamination of a sample.
- Sampling devices must be decontaminated between samples to prevent cross-contamination.

- Sampling devices must be decontaminated at the close of the sampling event before being taken off site.
- An acceptable alternative to cleaning and decontaminating sampling devices is using items cleaned or sterilized by the manufacturer that are discarded after one use. Care must be exercised to ensure that such previously cleaned or sterilized items do not retain residues of chemical or radioactive sterilizing agents that might interfere with analytical techniques.
- Whenever visible dirt, droplets of liquid, stains, or other extraneous materials are detected on the exterior of a sample container, the exterior surfaces must be decontaminated. This step should be performed before the container is placed in a sample cooler or shipping container.
- For sample containers used in controlled access areas, more rigorous cleaning and/or radiation monitoring may be required before removal from the site. Refer to the project-specific planning documents for details.
- Decontamination fluids/solids as well as other used cleaning supplies, such as paper towels and rags, should be treated as investigation-derived waste and managed in accordance with the project-specific planning documents.

6.2 DECONTAMINATION METHODS

The following decontamination methods are examples of some of those most commonly used in field investigations. Note that the decontamination methods described in this section are for guidance only; the project-specific planning documents and the SOPs referenced in them provide the actual procedures that must be followed. The field operations manager may need to adjust decontamination practices to fit the sampling situation and applicable requirements. All variances from the project-specific planning documents must be approved by the project manager in advance and documented. Procedures for packaging and disposing of all waste generated during decontamination are described in the project-specific planning documents.

6.2.1 Water Level Indicators

The following steps are taken to decontaminate water level indicators. Unless conditions warrant, it is only necessary to decontaminate the wetted portion of the measuring tape. It may be more practical to decontaminate the tape as it is being rewound, but with the reel several feet away from the wellhead (see project-specific planning documents):

1. Wash with detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.

6.2.2 Submersible Groundwater Pumps

The following procedures are taken to decontaminate submersible pumps used to collect groundwater samples. This is the general procedure for non-dedicated pumps, unless the dedicated pump is being removed from the well.

1. Disconnect and discard the previously used tubing from the pump. Wash the pump exterior with detergent and water.
2. Prepare and fill three containers with decontamination solutions consisting of Container 1, tap water and detergent solution; Container 2, a tap water rinsing solution; and Container 3, a deionized water final rinsing solution. The containers should be large enough to hold the pump and 1 to 2 liters of solution. An array of 2-foot-long 2-inch PVC pipes with bottom caps is a common arrangement. Buckets can also be used as long as the water covers the intake screen of the pump. The containers should be labeled to ensure that decontamination is completed in the correct steps. The solutions should be changed at least daily.
3. Place the pump in Container 1. Turn the pump on and circulate the detergent and water solution through the pump and then turn the pump off.
4. Place the pump in Container 2. Turn the pump on and circulate the tap water through the pump and then turn the pump off.
5. Place the pump in container 3. Turn the pump on and circulate the deionized water through the pump and then turn the pump off.
6. Disconnect the power and remove the pump from Container 3.
7. Decontaminate the power lead by washing it with detergent and water, followed by tap water and a deionized water rinse. This step may be performed before washing the pump, if desired.
8. Wind the power lead back on a reel, and place the pump and reel in a clean plastic bag.

6.2.3 Bladder Pumps

The following procedures are used to decontaminate bladder pumps that use disposable bladders. If the bladder pump being used does not have a disposable bladder, the decontamination procedures outlined in Section 6.2.2 should be used.

1. Disconnect and discard previously used tubing from the pump.
2. Completely disassemble the pump, being careful not to lose the check balls, O-rings, ferrules, or other small parts.
3. Remove and discard the pump bladder.

4. Clean all parts with tap water and detergent, using a brush if necessary to remove particulate matter and surface films.
5. Rinse thoroughly with tap water.
6. Rinse thoroughly with deionized water.
7. Install a new pump bladder.
8. Reassemble the pump and wrap it in aluminum foil or store it in a decontaminated pump storage tube.

6.2.4 Small Tools/Samplers

The following procedures are used to decontaminate small tools/samplers (e.g., stainless steel bowls, sample trowels, and hand augers).

1. Wash the tools/samplers with detergent and tap water, using a brush to remove particulate matter and surface film.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Wrap the tools/samplers in aluminum foil or place them in a clean plastic bag.

6.2.5 Drilling and Direct-Push Technology Sampling Equipment

These procedures are used for drilling and direct-push technology (DPT) sampling activities involving the construction of monitoring wells to be used for collecting groundwater samples or for collecting soil and groundwater samples.

6.2.5.1 Drill and DPT Rig

Any portion of the drill or DPT rig or backhoe over the borehole or sample location that has come into contact with soil or groundwater (mast, backhoe bucket, drilling platform, hoist, cathead) should be steam cleaned (detergent and high-pressure hot water) between boreholes or sample locations. A decontamination pad should be constructed as specified in the project-specific plans to contain soil and decontamination fluids.

6.2.5.2 Downhole Drilling and DPT Equipment

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment.

1. Wash the equipment with tap water and detergent, using a brush if necessary to remove particulate matter and surface film. Steam cleaning may be necessary to remove matter that

is difficult to remove with the brush. Drilling equipment that is steam cleaned should be place on racks above the floor of the decontamination pad. Hollow-stem augers, drill rods, drive casing, and other equipment that is hollow or has holes that transmit water or drilling fluids should be cleaned on the inside with vigorous brushing or steam cleaning.

2. Rinse the equipment with tap water.
3. Remove the equipment from the decontamination pad and cover it with clean plastic or reinstall the equipment on the drill rig.

6.3 QUALITY CONTROL

The effectiveness of the decontamination procedures is monitored by submitting samples of rinse water to the laboratory for low-level analyses of the parameters of interest, also referred to as equipment blanks. An attempt should be made to select different sampling devices each time devices are decontaminated to ensure that a representative sampling of all devices is obtained over the length of the project. Equipment blanks should be collected as specified in the project-specific planning documents.

7.0 RECORDS

Documentation generated as a result of this procedure is collected and recorded in a field logbook in accordance with procedures listed in SOP 300.04: *Field Logbook Use and Maintenance*.

8.0 REVISION HISTORY

Revision 0		Initial Release
Revision 1	December 2010	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2		Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	July 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 4	February 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 5	June 18, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 2.01 to 411.02.

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SOP 411.03, SIB Project Area, PHSS
(Source: Subsurface Utility Avoidance)

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HydroGeoLogic, Inc — Exceeding Expectations	**STANDARD OPERATING PROCEDURE**	
	Approved by:	Corporate Quality Manager

Subsurface Utility Avoidance	**SOP No.: 411.03 (formerly 401.01)**
	SOP Category: Environmental Services
	Revision No.: 3
	Revision Date: September 29, 2020
	Review Date: September 2022

1.0 SCOPE AND APPLICABILITY

This procedure applies to work that involves penetrating the soil surface with powered equipment during drilling or excavation activities. It is permissible to use a client's or facility owner/operator's utility avoidance procedure in lieu of this procedure if it provides equivalent protection.

For overhead utility lines avoidance, see the following procedures:

- HGL H&S Procedure 21: *Excavation and Trenching*,
- HGL H&S Procedure 27: *Drilling Safety*,
- HGL H&S Procedure 32: *Aerial Lift and Elevated Work Platform*, and
- HGL H&S Procedure 40: *Forklifts and Earthmoving Equipment*.

1.1 SUMMARY OF METHOD

This procedure establishes the minimum requirements for avoiding damage to subsurface utilities from unintentional contact with powered equipment.

1.2 HEALTH AND SAFETY WARNINGS

This procedure is not intended to address the hazards associated with subsurface investigation activities. Consult HGL Health and Safety (H&S) Procedure 21: *Excavation and Trenching* and Procedure 27: *Drilling Safety* for safety guidance and requirements. Do not perform intrusive work in areas that may contain unexploded ordnance (UXO) without a UXO escort and clearance by qualified UXO personnel.

Follow the procedures below if a utility is damaged during work (refer to the project Health and Safety Plan or Accident Prevention Plan for project contact information):

- If a gas line has been breached, shut down all nearby equipment that might provide an ignition source.
- Evacuate the immediate area of the breach unless the breached item clearly poses no hazard to personnel, as determined by the Site Safety and Health Officer (SSHO).
- Notify the owner/manager of the utility and emergency services (as appropriate) immediately. Note that in many cases contacting the public utility locating service (using One Call, calling 811, or going online to https://call811.com) will notify the member utility. In some states it is required by law to notify the One Call service.

- If a buried electrical line is cut or damaged, call the power company emergency number for instructions.
- Notify the HGL Project Manager and H&S Director.
- Do not proceed with activities until the situation has been assessed by qualified H&S or utility owner personnel and written permission to resume work has been granted by the Project Manager and H&S Director.

1.3 PERSONNEL RESPONSIBILITIES

The Project Manager is responsible for the following:

- Obtaining any facility-specific requirements/procedures for intrusive work, such as a dig permit;
- Obtaining specifications and "as-built" drawings for any buried lines, utilities, tanks, or other structures at the site and reviewing the proposed locations for drilling or excavation relative to those structures;
- Verifying that if client or facility utility avoidance procedures are to be used, they provide protection that is equivalent to that provided by this HGL SOP;
- Arranging for additional utility location beyond One Call service, such as private utility locating subcontractors, if
  - No accurate utility maps or "as-built" drawings are available,
  - Work is being performed close to high-value or high-hazard buried utilities, or
  - Work is being performed in residential areas, inside buildings, outside of public rights-of-way, or in other locations where unmapped utilities may be present.
- Arranging for UXO escort and UXO clearance if unexploded ordnance may be present;
- Ensuring that utility owner/manager emergency phone numbers are in emergency contact lists; and
- Ensuring that arrangements and procedures for subsurface utility avoidance are addressed during the pre-mobilization readiness review. These include establishing procedures for intrusive activities within 5 feet of a utility; arranging for HGL not to be responsible for damages to subsurface utilities in accordance with the One Call service or facility liability provisions; and obtaining a written waiver from the client or site owner, if needed.

The Field Manager is responsible for the following:

- Contacting the state utility One Call service and/or facility utility program to locate and mark subsurface utilities and hazards at the worksite and to update them during the duration of the work;

- Completing the utility avoidance checklist attached to this SOP before the start of intrusive work;
- Ensuring that fieldwork involving powered drilling or excavation follows this procedure and other applicable requirements including HGL H&S procedures;
- Ensuring that site personnel are trained on the requirements of this SOP;
- Discussing utility-related emergency procedures in the pre-mobilization readiness review and daily safety briefings;
- Ensuring that all drilling or excavation locations are marked using high-visibility paint or some other recognizable and durable marking;
- Reviewing utility maps against field markings and resolving any inconsistencies or questions with the One Call service or facility utility program;
- Verifying at the start of each workday that drilling/excavation and utility markings are intact and clear, and contacting the One Call service or facility utility program to re-mark utilities if necessary;
- Understanding the utility incident reporting requirements for the state and facility where the work is done; and
- Reporting immediately any unintentional contact or damage to subsurface assets or hazards.

1.4 DATA AND RECORDS MANAGEMENT

Steps taken to avoid damaging utilities must be documented in the appropriate records such as the utility avoidance checklist, pre-drilling checklist, inspection checklist from H&S Procedure 21, field logbooks, and photographs, including photographs of the utility marks relative to the boring/excavation prior to the start of intrusive activities. Copies of utility maps, completed dig permits, and other relevant documentation must be kept at the project site and in the project files.

2.0 PROCEDURE

The Field Manager is responsible for executing this procedure on the project site and completing the Utility Avoidance Checklist in Attachment 1 before the start of intrusive work.

Before commencing intrusive work using powered equipment, contact the public utility locating service (using One Call, calling 811, or going online to https://call811.com), the facility's utility program, or a private utility contractor. Utilities not in the public right-of-way are typically not marked by the One Call service.

Complete a walk-over survey of excavation or drilling locations prior to intrusive activities and then visually confirm that known utilities have been marked as appropriate and that markings are consistent with visible cues of possible subsurface utilities including the following:

- Utility posts/line markers,
- Water shutoff valves,
- Sewer cleanouts/manhole covers,
- Discharge pipes,
- Stormwater inlets,
- Irrigation wells and pivots,
- Fire hydrants (hydrants are typically offset from the water main by several feet),
- Junction boxes,
- Electrical poles with conduit into the subsurface,
- Light poles,
- Storage tank vents,
- Transformers, and
- Cuts/patches in pavement.

Determine if proposed drilling or excavation locations are immediately between storage tanks and product dispenser systems, between storage tanks and control units or buildings, between underground storage tanks and tank air vents, between manholes and sewer connections, or between any features that are likely to be connected by a subsurface utility, and if they are, relocate the drilling/excavation locations if possible. Identify facility assets (for example, equipment, control centers, fire suppression systems, vital communication systems, hospitals, polices stations) that may be impacted or harmed if a utility is breached. Know the location of any shutoff valves in the area (for example, irrigation lines). Take photographs of all drilling and excavation locations prior to, during, and after work is complete.

Contact the One Call service or facility utility program if a utility is encountered that has not been marked or communicated to complete the locate and marking for that utility. If a utility is encountered and has not been marked or communicated by the One Call service or facility utility program, notify the Project Manager and H&S Director, who will determine the next step, such as arranging an independent utility survey and notifying the One Call service or facility utility program of the failure.

If a planned intrusive location is within 5 feet of a utility, reposition the work if feasible and request a new utility clearance by the One Call service. Consult the Project Manager before deciding to relocate a planned drilling or excavation location; obtain client approval if necessary. Keep in mind that many utility markings are approximations and that the utilities may be several feet from the markings.

For drilling operations, if it is not feasible to relocate the drilling location, excavate at least the first 5 feet (deeper if it is likely that there are deeper utilities) of boreholes with a low-impact technique such as hand augering, hydrovacing, or air knifing. Pre-excavation of boreholes using low-impact techniques must also be performed under the following conditions:

- The location of utilities is uncertain.
- The work is being done in a residential or high population commercial area.

It is permissible to omit low-impact pre-excavation of boreholes under the following conditions:

- It has been verified that no hazardous (for example, gas, liquid fuel, or electric) or mission-critical communication (for example, fiber optic) subsurface utilities exist within 25 feet of the planned drilling location and that HGL will not be responsible for damages to subsurface utilities in accordance with the One Call service or facility liability provisions; or
- A written waiver has been obtained from the client or site owner.

Situations that do not fit the above criteria should be resolved at the pre-mobilization readiness review. Decisions to forego low-impact pre-excavation of drilling boreholes are subject to Program Manager approval through the issuance of a Subsurface Utility Avoidance memorandum or Field Work Variance. The memorandum must detail the justification to forgo the procedures outlined in this SOP, H&S Procedure 21: *Excavation and Trenching* and H&S Procedure 27: *Drilling Safety*. The revised procedure must be discussed during the readiness review meeting with all task participants, and the signed memorandum must be included with the readiness review form and/or pre-drilling checklist.

Criteria for determining the need to pre-excavate boreholes are summarized below:

Criterion	Utility Location	Other Condition	Decision
a	Within 5 feet		Pre-excavate
b	Between 5 and 25 feet	Uncertain if utilities are present	Pre-excavate
c	More than 25 feet	No hazardous or high-value utilities are present	May skip pre-excavation
d	Uncertain	Residential or high-population commercial	Pre-excavate
e	Uncertain	No hazardous or high-value utilities are present; HGL liability waived	May skip pre-excavation
f	Uncertain	Not d or e	Site-specific; resolve at pre-mobilization readiness review and document in review minutes

For excavation operations, if utilities are located within the planned excavation or within 5 feet of the limits of the excavation, the precise location of those utilities must be determined by excavating with low-impact tools such as hand auger, shovel, hydrovac or air knife. This may be necessary at several locations within the excavation area to confirm that the apparent route and depth of the utility do not change. **If a utility extends throughout the area to be excavated, the utility must be exposed to confirm its location and depth at least once every 10 feet. The utility must be exposed continuously, using low impact techniques, when performing powered excavation within 5 feet of the utility.**

HGL must inspect excavations managed by subcontractors at sufficient frequency and at least daily to confirm that the subcontractor is complying with these requirements and must require the subcontractor to make corrections if they are not in compliance.

If subsurface obstructions prevent reaching a depth of 5 feet using low-impact techniques, verify that the obstruction itself is not a utility (for example, a concrete sewer pipe versus concrete rubble). Conversely, if there is a credible probability that utilities are present at depths greater than 5 feet, the low-impact excavation may be continued to greater depths. **It is not permissible to omit low-impact excavation due to a lack of suitable equipment.**

Inspect the low-impact excavation and excavated material for indications of utilities, such as the edge of a pipe visible in the sidewall of the excavation or the presence of pea gravel that may be pipe bedding. If a subsurface utility is unintentionally encountered at any time during a low-impact or powered boring or excavation, cease all work in the immediate area and contact the SSHO and Field Manager.

Any material generated during pre-excavation activities is managed in accordance with the project-specific planning documents.

Maintain and protect markings for utility locations during the work. If utility markings are weathered away or removed, or if the location or boundaries of the activity change, repeat the locating processes and replace the markings. Many utility incidents occur when the boundaries of excavations are changed or the marked utility locations wear off.

3.0 REFERENCES

HGL, H&S Procedure 21: *Excavation and Trenching*.
HGL, H&S Procedure 21.1: *Excavation and Trenching*, Appendix A, Inspection Checklist.
HGL, H&S Procedure 27: *Drilling Safety*.
HGL, H&S Procedure 32: *Aerial Lift and Elevated Work Platform*.
HGL, H&S Procedure 40: *Forklifts and Earthmoving Equipment*.

3.0 REVISION HISTORY

Revision 0	July 2016	Initial Release
Revision 1	May 2017	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 2	June 1, 2018	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting.
Revision 3	September 29, 2020	Updated to incorporate lessons learned on the process and to reflect changes in SOP formatting, which included changing the SOP number from 401.01 to 411.03.

ATTACHMENTS

Attachment 1 – Utility Avoidance Checklist

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ATTACHMENT 1
UTILITY AVOIDANCE CHECKLIST

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UTILITY AVOIDANCE CHECKLIST

Date: ____________________ Project/Site: ______________________________________

Field Manager: ____

Work to be Performed: ____

Consideration	Y	N	Explanation	Initial
1. Has a dig permit been obtained and approved?				
2. Has state One Call service been contacted?				
3. Has facility utility program been contacted?				
4. Has a private utility locating survey been conducted?				
5. Have as-built drawings been reviewed for utilities or subsurface hazards (e.g., USTs)?				
6. Has a visual inspection of the work area(s) been completed, including taking photographs?				
7. Have all known utilities and subsurface hazards been clearly marked?				
8. Has a visual inspection indicated the possible presence of other utilities or subsurface hazards?				
9. Are intrusive activities being conducted within 5 feet of a utility?				
10. If Item 9 is YES, can activity be relocated?				
11. Are any final drilling locations within 5 feet of a utility; are utility locations uncertain or working in residential or high population area? If YES, excavate first 5 feet using low-impact techniques				
12. Are any utilities within 5 feet of the excavation limits? If YES, determine precise location with low-impact techniques.				
13. Can drilling proceed WITHOUT excavating the upper 5 feet with low-impact techniques? Explain why.				
14. If working near overhead power lines, is a minimum clearance of 20 feet being maintained?				
15. Has written approval been granted by the Program Manager to deviate from SOP 411.03? Attach to checklist.				
Other considerations:				

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SOP A-1, SIB Project Area, PHSS
(Source: Hydrocarbon Field Screening)

Standard Operating Procedure
Hydrocarbon Field Screening by Sheen Test

1.0 Purpose and Applicability

The Standard Operating Procedure (SOP) for sheen test describes a procedure to visually estimate areas of possible hydrocarbon impacts in soil or sediment. In addition, screening results can be used to aid in the selection of soil/sediment samples for chemical analysis. The field screening method includes a visual examination and water jar screening test.

Visual screening consists of inspecting the soil/sediment for stains, nonaqueous-phase liquids (NAPL), and/or sheens indicative of residual hydrocarbons. Visual screening is most effective at detecting heavy hydrocarbons, such as creosote, free-phase NAPL or high hydrocarbon concentrations. Water sheen screening from a representative soil/sediment sample is a more sensitive method at detecting the presence of hydrocarbons.

2.0 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Health and Safety

This section presents the potential hazards associated with this technique. The site-specific Health & Safety Plan (HASP) will take precedence over this document. Note that sample collection usually requires Level D personal protection unless there is a potential for airborne or dermal exposures to site contaminants.

Health and safety hazards include but are not limited to the following:

- Dermal exposure to potentially contaminated media: proper personal protective equipment (PPE) is used to mitigate dermal contact including the impact of splashes of water or media to skin and/or eyes;
- Inhalation exposure when handling impacted media: respiratory protection should follow the procedures outlined in the project Site-Specific HASP; and
- Broken glass, in the event that a glass jar is used: use care when handling glassware.

4.0 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper screening procedures may be followed:

- Approximately one cubic-inch of media to be screened;
- 4 of 8 oz. wide-mouth, clear glass jar;
- Stirring devise (i.e. spoon);
- Squirt bottle; and
- Supply of distilled water.

5.0 Methods and Procedures

The strategy used to collect soil/sediment samples in the field for sheen testing will depend on the nature/grain size of the material and the type of hydrocarbon. Discrete samples may be collected from specific depths where NAPL is likely to occur. When lithology is course-grained material over fine-grained material, then a sample should be collected just above this interface where NAPL may be pooling above the "aquitard". Similarly, where fine-grained material overlies a coarse-grained layer with suspected impacts, the sample should be collected just below the contact. When lithology is fine-grained, then a sample should be collected near the contact with the coarse-grained layer. Alternatively, when lithology is finely bedded (< 1-inch thick), then homogenized samples may be collected over a larger depth interval to gain an "average" observation.

If the sample is being collected from inside a sediment core tube, the tube should be cut open longitudinally along the length of the core tube to prevent additional smearing. Make sure the interior of the sediment is exposed as a "fresh surface". Be sure to discard any material along the inside side-walls of the core tube; this is called the "smear zone". The smear zone may mask the true stratigraphy of a subsurface core sample. Then, use a spoon to scrap material across the "fresh" surface of the depth interval of interest, and place into sample jars for further observation. Once the sample volume is collected (approximately 1 oz or more depending upon grain size) the sample is examined and tested as described below.

Visual Examination

In the field, observe sediment core tubes or soil samples for evidence of NAPL. Look at the material and note color and type/nature of occurrence. Observe the exterior and interio sidewalls of the sampling container for signs of staining. If wet, observe the nature of liquid. Among gravels, observe the surface of the gravel for signs of sheen and/or NAPL.

Water Sheen Test

Water sheen screening involves placing soil/sediment in a clear glass jar or a black plastic pan partially filled with water, and observing the water surface for signs of a sheen. The volume of soil/sediment required for observation is approximately one cubic inch, or 10 mls, or about one tablespoon of media. For practical application in the field or lab, place about one cubic inch of soil/sediment (roughly 1 oz) in a 4 to 8 oz jar filled ¼-full with water. For larger volumes, use about 2 oz of material in an 8 oz wide-mouth glass jar filled ¼-full with water. Even larger volumes are needed for gravel. A plastic baggy may be substitute for a glass jar if field conditions require. Crush the material in the jar using a stirring devise (i.e., spoon), and shake the sealed jar vigorously for 30 seconds and allow the material to settle. Observe the water surface and sidewalls of the jar for signs of sheen, LNAPL, and DNAPL. Quantify the amount of sheen and blebs in the water surface using the following sheen classification:

No Sheen	No visible sheen on water surface
Slight Sheen	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly
Moderate Sheen	Light to heavy sheen, may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas without sheen on water surface
Heavy Sheen	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen; visible droplets of immiscible liquids (i.e. NAPL)

Quantify the spatial coverage of sheen and size/diameter NAPL blebs if observed. The color is often described as rainbow or metallic for sheens and dark brown to black for blebs, droplets, and staining. Observe the sidewalls of the jar and estimate the thickness of LNAPL on the water surface and the thickness of DNAPL accumulated at the bottom of the jar. Record visual signs of staining on jar sidewalls and stirring devise.

Field screening results will be recorded on the field logs forms or in a field notebook. Field screening results are site-specific and location-specific. Factors that may affect the performance of this method include: operator experience (experimentation may be required before routine screening is started) ambient air temperature, soil type, soil moisture, organic content, and type of hydrocarbon. Headspace screening may be collected to help correlate results and observations.

6.0 Quality Assurance/Quality Control

Not applicable.

7.0 Documentation

Documentation may consist of all or part of the following:

- Field sampling forms;
- Field log book; and
- Chain-of-custody forms.

Field records should contain sufficient detail to provide a clear understanding of how and where samples were collected. All documentation shall be placed in the project files and retained following completion of the project.

Field Description Key for Potential NAPL in Sediment

The intent of this field description key is to provide field personnel with guidelines for logging and observing sediment conditions associated with potential presence of Non-Aqueous Phase Liquid (NAPL) in a consistent and factual manner.

VISUAL DESCRIPTORS

The range of conditions that could exist in sediments include:

- **NAPL** (Non-Aqueous Phase Liquid) – a separate phase liquid that may be lighter than water (LNAPL) or denser than water (DNAPL). NAPL can have varying consistency (viscosity) and can range from non-viscous to highly viscous (taffy-like). NAPL observations should be accompanied by applicable olfactory with smell (see descriptors below) and other visual observations (e.g., color and viscosity). The visual appearance of NAPL should be noted using descriptors below as appropriate. If NAPL is identified, then a sheen or shake test should be completed as described in this SOP in the Hydrocarbon Field Screening by Sheen Test portion.
    - **Free Product –** the entirety of the pore space for a sample interval is saturated with NAPL. Care should be taken to ensure that the saturation described is not related to water in the sample. Depending on the viscosity, NAPL saturated materials may freely drain from a soil sample and should be documented accordingly.
    - **Present–** In some cases, NAPL may be present in the pore spaces, or some of the pore spaces, but not coating the soil grains. The NAPL occurrence may be greater than blebs but not freely draining (saturated) and not hydraulically continuous. In these cases, the appearance/abundance of the NAPL should be noted.
    - **Blebs or Globules–** discrete, multi-shaped NAPL in or on the soil matrix. Include additional descriptors to the extent practicable such as the approximate size (typically ranging in size from 0.01 to 0.05 inches in diameter) and quantity (number of blebs or qualitative estimate) to the extent practical.
    - **Coated –** soil grains are coated with NAPL – there is <u>not</u> sufficient NAPL present to saturate the pore spaces. Use modifiers such as light, moderate or heavy to indicate the degree of coating.
    - **Semi-solid NAPL–** NAPL that is present as a super viscous liquid and appears in a solid or semi-solid phase. The magnitude of the observed solid NAPL should be described (discrete granules, tarry balls, taffy-like, or a solid layer).
- **Sheen –** iridescent sheen. The sheen characteristics need to be described in the field log, including the color, and iridescent sheens need to be distinguished from bacterial sheens which tend to break up at angles on the water surface; whereas a non-bacterial sheen will be continuous and will not break up. Sheens can be described as:
    - Discontinuous sheen (i.e., spotty, streaks, florets) within a section of core and does not fill sediment pore spaces.

  - Continuous sheen (i.e., covering an area greater than 1 square inch) within a section of core but does not fill pore spaces. Describe percent cover.

- **Stained –** visible, unnatural discoloration of the soil, with no visible NAPL.

Other Visual Impacts and Descriptors

In many cases, observed NAPL may be associated with a particular stratigraphic layer (e.g, sand lamination, woody debris layer, gravel lense), gas bubble, or void; NAPL distribution in relation to stratigraphy must be described. What does the material look like immediately above and below the area with suspected NAPL (e.g, clay). Impacts should be described using other visual descriptors as well, as applicable. Descriptors may include, but not be limited to, color, consistency, thickness, viscosity, water content, associated stratigraphy, presence shell or wood fragments or other debris, does NAPL flow out of the core tube, does it appear more or less viscous than water, results of jar sheen test, etc. Also note the staining of sampling equipment, and interior and exterior side-walls of the sampling tube, especially if entrainment of NAPL up the side-walls is suspected as an artifact of sample collection.

OLFACTORY DESCRIPTORS

Field personnel will not conduct olfactory testing as part of sample processing, because vapor inhalation is a potential health and safety risk. However, if incidental odors are noted by field personnel during regular sample processing activities, field personnel will record this observation in the field forms. General descriptors that could be used are the following:

- Note odors similar to mothballs, driveway sealer, highway paving oil, sewage or other odors that are acrid, burnt, or sulfur-like, etc.
- Other odors that are not believed to be natural should also be identified with descriptors such as organic, ammonia, sweet, chemical etc., as applicable.
- Use modifiers such as strong, moderate or slight to indicate intensity of the observed odor.
- In instances where multiple odors are present, a combination of descriptors should be used to clearly identify where these co-mingled impacts are present.

However, olfactory descriptions are more subjective than visual inspections. Visual inspection may be aided by a PID, ultraviolet (UV) fluorescence examination, shake test, or similar device, to monitor and record organic odors and suspected NAPL in the field. One may also consider collecting a sample of the suspected NAPL to assess physical characteristics and potential mobility.

Last revised by AGF and Geosyntec on 1/18/18
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SOP A-2, SIB Project Area, PHSS
(Source: PID Screening and Calibration Procedures)

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PID Field Screening (Integral 2004)

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Except for sample volumes collected for volatile analytes, sediment from each subsample will be individually mixed in the decontaminated, stainless-steel bowl to a uniform color and texture using a decontaminated, stainless-steel spoon. The sediment will be stirred periodically while individual samples are taken to ensure that the mixture remains homogeneous. Care will be taken to not include sediment that is in direct contact with the aluminum tube. In addition, the cutting of the aluminum tube can introduce metal shavings to the core sediment. Care will also be taken to avoid mixing these shavings into the homogenate. Pre-labeled jars for chemical testing will be filled with the homogenized sediment.

The types and number of field QC samples for subsurface sediment samples will follow the same guidelines prescribed for surface sediment samples. If additional volumes of sediment are required to perform all analyses in addition to QC analyses, an additional core may need to be collected from the same location and subsampled and homogenized accordingly.

Sample handling and storage procedures will follow those described for surface sediment samples in Section 4.6.1 with the following exception. When required, sediment subsamples for volatile organics will be collected from within appropriate intervals following the opening of the core and designation of the lithologic units. This process will minimize the release of volatile organics caused by mixing. Rinsate blanks will be performed at the same frequency (5%) as performed for the surface sediment sampling program.

4.6.4 Subsurface Sediment Sample Field Screening

In addition to visual observation, headspace screening using a photoionization detector (PID) and/or flame ionization detector (FID) may be used on all sample intervals to aid in the selection of samples to be analyzed.

Headspace Screening

Headspace screening involves the semi-quantitative measurement of total volatile compounds in the air above the sample material. Headspace concentrations will be measured using the following procedure.

1. A small representative sample will be collected from each sample interval to be screened using a decontaminated sampling spoon. The material will be placed in a resealable plastic bag or glass jar with a septum lid.

2. The bag or jar will be tightly sealed (the jar with aluminum foil and plastic lid with septum opening), and the material will be allowed to warm at least to the ambient temperature (>32^{o} F). The sample will be allowed to sit for at least 10 to no more than 60 minutes to allow headspace concentrations to develop, and shaken

periodically for at least 30 seconds at the beginning and end of the development period.

3. The PID/FID probe tip will be inserted into the container within the headspace, with care taken to avoid taking sediment or moisture into the probe.

4. The highest reading (excluding possible erratic readings) on the meter will be recorded for the sample.

5. The deepest sample interval showing a response during headspace screening will be submitted in the initial round of analyses.

4.7 WASTE DISPOSAL

Any excess water or sediment remaining after processing will be returned to the river in the vicinity of the collection site. Any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station.

All disposable materials used in sample processing, such as paper towels and disposable coveralls and gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill. Phosphate-free, detergent-bearing, liquid wastes from decontamination of the sampling equipment will be washed overboard or disposed of into the sanitary sewer system. Waste solvent rinses will be held in sealed plastic buckets and disposed of into the sanitary sewer. Oily or other obviously contaminated investigation-derived waste will be placed in appropriate containers, and a waste determination will be made before it is disposed of at an appropriate facility.

4.8 SAMPLE HANDLING AND TRANSPORT

Since samples collected in support of CERCLA activities may be used in litigation, their possession must be traceable from the time of sample collection through laboratory and data analysis to introduction as evidence. To ensure samples are traceable, the following procedures will be followed.

4.8.1 Chain-Of-Custody Procedures

Samples are in custody if they are in the custodian’s view, stored in a secure place with restricted access, or placed in a container secured with custody seals. A chain-of-custody record will be signed by each person who has custody of the samples

STANDARD OPERATING PROCEDURE

PID EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE

Introduction
The standard operating procedure (SOP) for photoionization detector (PID) equipment calibration describes a procedure to confirm that monitoring equipment used for screening the quality and safety of sediment samples are operating within the manufacturer's specifications.

Calibration
PIDs will be calibrated on a daily basis each morning prior to making measurements and will be adjusted to operate within the manufacturers' specifications. The PIDs will be calibrated using 100 parts per million (ppm) isobutylene calibration gas provided by the equipment vendor.[1] After calibration, the equipment output will read "Span 1 is done and reading is XXX." Manufacturer states that reading should be close to span gas value. Field crew is using a span gas value of 100 ppm ± 5%. If readings are outside of this value, then equipment will be sent back to the manufacturer for maintenance. All calibration information shall be recorded in the project logbook.

Special attention shall be noted by field crew to instruments that may be affected by the change in the ambient temperature or humidity. Calibration checks should also be performed when sampling conditions change significantly, sample matrix changes, and/or readings are unstable or there is a change of parameter measurements that appear unusual.

As needed through the day, a black marker may be used to confirm a "positive" reading by the PID instrument.

Maintenance
All field monitoring equipment and accessories are to be maintained in accordance with the manufacturer's recommendations and specifications and/or established field practices. All maintenance will be performed by qualified personnel and documented in the field logbook or returned to manufacturer for maintenance.

Equipment requiring battery charging shall be charged as recommended by the manufacturer. Backup batteries for meters requiring them shall be included as part of the meters' accessories. Care must be taken to protect meters from adverse elements. Protective measures may involve placing the meter in a large plastic bag to shield it from the weather.

Documentation
All field equipment calibration, maintenance, and operation information shall be recorded within the field logbook to document that appropriate procedures have been followed and to track the equipment operation.

[1] 100 ppm calibration gas = "Span 1"

Logbook entries shall contain, but are not necessarily limited to, the following:

- Equipment model and serial numbers
- Date and time of calibration or maintenance performed
- Calibration standard used
- Calibration lot number and expiration date if listed on bottle
- Calibration procedure used if there are multiple options
- Calibration and calibration check readings, including units used
- Problems and solutions regarding use, calibration, or maintenance of the equipment
- Other pertinent information

Field records should contain sufficient detail to provide a clear understanding of which equipment was used and how equipment was calibrated. All documentation shall be placed in the project files and retained following completion of the project.

SOP A-3, SIB Project Area, PHSS
(Source: Sampling Photography)

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STANDARD OPERATING PROCEDURE

CORE PHOTOGRAPHY PROCEDURES FOR SEDIMENT CORING

Purpose

The purpose of this standard operating procedure (SOP) is to describe core photography procedures.

Scope and Applicability

This SOP is applicable to taking digital photographs of subsurface sediment cores.

Equipment and Materials

Equipment and materials for taking digital photographs include the following:

- Digital camera
- Spare batteries
- Tripod
- Color calibration card
- Measuring tape
- Light stands
- Digital camera-carrying case and manual
- Photo log form
- Dry-erase board
- Dry-erase marker
- Black waterproof pen

Typical Camera Features

- Save photographs (in standard mode) directly to a memory stick or comparable device
- Auto focus; manual focus available if required
- Zoom
- Brightness control
- Playback of photographs on camera screen
- Display of photograph number, date, and time

- Timed or remote release
- Display showing time remaining on battery and remaining disk capacity
- Ability to protect and delete images that have been taken

Camera Use

A digital camera will be used by the core processing team to photo document the subsurface sediment cores. The field team leader will be responsible for digital photograph documentation or for assigning documentation duties to a team member. Digital photographs will be collected at a high-pixel setting such that enlargements can be made with minimal degradation in picture quality.

Photograph Documentation Procedures

Field Team Responsibilities

The core processing team will keep a daily hard copy log of all photographs. The following digital photograph data will be collected:

- Date and time—as provided by the camera display
- Team members—list each team member
- Camera identifier (type, model, equipment number)
- Sample Location ID and depth interval
- Photograph ID—record the number of the photograph and the photograph file name (as coded below)
- Description—the target of the photograph

Photography Procedures

- Sediment cores should be photographed indoors with flood lights and oriented so that shadows are eliminated.
- The camera should be affixed to a tripod and photos taken using a timed or remote release to minimize shaking.
- The axis of the camera lens should be as close to perpendicular as possible to the core to minimize distortion of core and linear features.
- A measuring scale (e.g., tape measure or ruler) should be placed adjacent to the edge of the core as a size reference.
- A color proof strip should be included in the photo to ensure true color reproduction during photo post processing.
- The core Location ID and depth interval should be written onto a dry erase board and included in the photo frame.

Digital Photograph File Name

At the end of each field day, the member of the field team who is responsible for the camera will transfer the electronic data from the camera to the field operations computer. The folder structure will be as follows (or as specified in the Data Quality Management Plan [DQMP]):

\\DATA\PHOTOS\YYYYMMDD\SAMPLE AREA\file\[1, 2, 3, ...N]

The notation YYYYMMDD represents the year, month, and day. The sample area is the sampling area name (e.g., Willamette River). The individual files for the day (e.g., file 1, file 2, file N) will be placed within this folder using the default file identifier provided by the camera.

Transfer of Information and Archive

After the photograph disks have been uploaded, the original hard copy of the photograph log will be initialed and dated by the team member who downloaded the photographs, then archived by the field team leader.

Sample Processing Coordinator Responsibilities

The field team leader will be responsible for 1) reviewing electronic photographs and the logs as they are made available to ensure consistency and completeness of annotations; 2) collecting and archiving the hard copies of the photograph logs; 3) reviewing electronic photographs and the logs as they are made available to ensure consistency and completeness of annotations; and 4) notifying the sampling team leader of apparent inconsistencies and making recommendations for corrective action.

Key Checks and Items

Important checks for digital camera management include the following:

- Make sure the camera's battery is fully charged on a daily basis.
- Keep extra memory sticks available.
- To save battery life, use flash only when necessary.
- Make sure the camera quality level is set at "best" or equivalent (high pixel).
- Review photograph records periodically to ensure that the electronic photographs, dry erase board information, and the Specimen Tally and Location Form agree.
- Leave enough time at the end of the field day to transfer the data.

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SOP A-4, SIB Project Area, PHSS
(Source: Storm Drain Sampling)

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1. PURPOSE AND SCOPE

The following text describes the techniques that will be employed to collect sediment samples at specified locations. For the purposes of this project, and where necessary, HGL will adopt the SOP for Confined Space Entry to be performed by certified contractors.

2. REQUIRED EQUIPMENT

The following equipment and supplies will be used for sediment sample collection:

- Photoionization detectors (PIDs)
- Laboratory-supplied containers
- Decontamination kit (buckets, brushes, Alconox, and tap and deionized water)
- Camera
- Sharpies/pens
- Labels
- Chain-of-Custody forms
- Ice and cooler
- 25-foot grab sample pole with 12-oz. sample cup
- Paper towels
- Personal protective equipment (PPE), including hard hat, boots, high-visibility vest, safety glasses, and nitrile gloves

3. SEDIMENT RETRIEVAL METHODS

The methods for retrieving the accumulated sediment are presented below.

- Using safe lifting techniques, traffic controls (if needed), and implementing all health and safety protocols, open the manhole cover.
- Observe sediment volume present. If the volume is adequate for analytical laboratory requirements (8 oz), proceed with sample collection consistent with this SOP.
- Using a grab sample pole fitted with a sample cup or stainless beaker, collect a representative sample by scooping the sediment from the accumulated location.
- Slowly raise the sample cup to the surface and place the sediment into the laboratory-supplied containers (decant water from top).
- Repeat the procedure until the sample container is filled with sediment.
- Label the sample container.
- Close the manhole cover.
- Decontaminate the sample cup before the next location is sampled.

4. DECONTAMINATION PROCEDURES

Decontamination of sampling equipment must be conducted consistently to ensure the quality of samples collected. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

Decontamination will occur after each use of a piece of equipment between sample locations. All sampling equipment that comes into contact with sampling media (grab pole, stainless beaker, cups, etc.) will be decontaminated according to EPA Region 10 recommended procedures. The following, to be carried out in sequence, is an EPA Region 10 recommended procedure for the decontamination of sampling equipment:

- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap water rinse
- Deionized/distilled water rinse (first rinse)
- Deionized/distilled water rinse (second rinse)

Equipment will be decontaminated in a predesignated area, and clean bulky equipment items will be stored in their cases or on visqueen in uncontaminated areas. Cleaned small equipment items will be stored in their cases or in plastic bags. Materials to be stored more than a few hours will also be covered.

5. FIELD FORMS

During each site visit to retrieve accumulated sediment, the field crews will complete a field form which will record the following information:

- Name of staff conducting sampling
- Location
- Date/time of sampling
- Presence and approximate depth of any water at the location
- Approximate volume of sediment sampled
- General comments/observations

Gravity SOP A-5
Source: Gravity Marine HVS Sampling)

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STANDARD OPERATING PROCEDURE (SOP) SW-27

HIGH-VOLUME STORM WATER SAMPLING FOR ANALYSIS OF COMPOUNDS WITH LOW DETECTION LIMITS

SCOPE AND APPLICATION

This SOP describes the protocol for collecting high-volume (HV) water samples using a Gravity PR2900 pump system coupled with a polyurethane foam (PUF) cartridge and a vortex separator, the collection of parallel peristaltic whole water sample, and the collection of physical sample parameters. This SOP is specific to HV techniques used for storm water sampling and should be an addendum to the primary projects Quality Assurance Project Plan (QAPP).

High volumes of surface water samples are collected to quantify surface water concentrations of targeted organic chemicals (e.g., dioxins, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods. This method also allows for quantification of hydrophobic organic chemicals (HOCs) in the suspended particle and dissolved phases of the water column.

HV storm water sampling techniques make it possible to obtain enough mass from the storm event to allow quantitation of the target compounds. In summary, a large volume of water is collected with a pump and passed through a vortex separator and then through a cartridge containing PUF material that binds the dissolved forms of the compound in question. The dissolved compounds that bind to adsorbent foam material (i.e. the PUF) are later extracted in the laboratory and measured on a gas chromatograph/mass spectrometer. Trace metal clean sampling techniques are also used for the collection of HV water samples to be analyzed for organic compounds and conventional parameters, such as total suspended solids, dissolved organic carbon, and total dissolved solids. Using these techniques guarantees a high level of sample integrity and minimizes the potential for contamination during sample handling.

This SOP utilizes and augments the procedures outlined in the San Francisco Estuary Institute's *Field Sampling Manual for the Regional Monitoring Program for Trace Substances* (David et al. 2001), the *Interagency Field Manual for the Collection of Water-Quality Data* (USGS, various dates), and U.S. Environmental Protection Agency (EPA) Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA 1996). A goal of this SOP is to ensure that the highest quality, most representative data are collected, and that these data are comparable to data collected by different programs that follow EPA guidelines.

STATION ACCESS

Prior to entering select areas for storm water sampling that are safe to access. It may be necessary to acquire permission from the landowner to access the property. Access permission must be acquired in advance of the sampling program and may require a written agreement.

STATION LOCATION

Water samples will be collected at specific HV locations identified in the project planning documents (e.g. Field Sampling Plan [FSP]). Samples will be collected over the period of the storm event so ensure locations have 24/7 access.

SUMMARY OF METHOD

At each station, dedicated/new Teflon™ tubing will be connected to a dedicated decontaminated primary pump attached to a pipe with weighted base mount and flow sensor and lowered into the storm water pipe making sure the primary pump inlet does not come into contact with any accumulated sediment. There will be a dedicated primary pump at each location, the pump is constructed with all stainless steel components and will be decontaminated before deployment. The primary pump variable flow is operated by a surface controller that will be set at approximately 3 L/min and will pump the storm water into a dedicated decontaminated surface level primary glass carboy which will in turn supply both the HVS outflow and whole water sample volume needed for continuous sample flow. Examples of the fully stainless steel primary pumps selected are the Geosub 2 from Geotech and the Proactive Monsoon from ECT Manufacturing. Both of these pumps are designed to continuously pump water to the surface where vertical distances exceed the capabilities of available peristaltic pumps, the pumping rates can also be accurately controlled at the surface using the manufacturer supplied controller units.

Two lengths of dedicated/new Teflon™ tubing will be inserted fully into the primary glass carboy, one of the sampling tubes will be directed to the internal HVS peristaltic pump intake, which leads to a high vortex separator. The high vortex separator is able to separate suspended sediments by forcing the water in a centrifugal fashion before exiting towards the 0.45 micron glass filter and then the PUF cartridge. Water is then drawn through the PUF cartridge which contains solid phase extraction resins that bind dissolved forms of the compounds in question (e.g., HOCs). A constant rate of water, approximately 1.5 L/min, is pumped through this system. Every 15 minutes the rate of water pumped is checked to ensure that water is flowing at a constant rate. To check that the pump is accurately delivering the desired rate of volume, the pump outflow must be checked with a l L graduated plastic cylinder and a timer. If the pump is not delivering the correct flow rate, fine adjustments must be made until the optimum flow is achieved.

After the desired volume has passed through the PUF cartridge, the HVS peristaltic pump is turned off and the PUF cartridge and the 0.45 micron glass filter are removed. Two stainless steel nuts that cap each end of the PUF cartridge are reattached. The cartridge is then labeled, taped, placed in resealable bags, and placed in a cooler with wet ice. The volume from the vortex separator containing the suspended particles sample is added to the 0.45 micron flat filter, and placed in a labeled 8 oz jar before being placed in a cooler with ice. The vortex sampler volume is removed by shutting the main line valve to the off position and opening the vortex outlet valve while running the pump for 10 seconds.

Physical field measurements and a separate whole water sample will be collected in tandem with the HVS sampling system by connecting the second Teflon™ tube to a secondary peristaltic pump, tubing set, and secondary glass sample carboy. This pump will also have a flow-thru chamber with YSI Exo multi-meter installed for continuous measurement of Dissolved Oxygen, PH, turbidity, and temperature. Assuming adequate sample volume, flow via the second tubing will be continuous at a similar or lower flow rate than the primary HVS tubing and discharge from the second tubing will alternate between filling the secondary glass carboy and pumping to waste. This set-up intends to keep samples coming out of both tubes representative of the total storm flow throughout the pumping duration, the continuous flow will ensure that the combined HVS and whole water sample collection pumping rates will be equivalent to the primary pump flow rate set to approximately 3 L/min to avoid the primary glass carboy being overfilled during the sample collection period. Once the secondary whole water sample is collected the peristaltic pump will be used to collect TSS and TOC samples from the agitated secondary glass sample carboy in laboratory supplied sample containers for analysis. The remaining whole water sample in the secondary glass sample carboy can be submitted to the laboratory for all other analysis in accordance with project planning documents.

PROCEDURES

The sampling team should comprise two people. Staff are needed to conduct the sampling and keep track of sample logging and sample processing.

Equipment Preparation

A sufficient amount of dedicated sampling equipment will be brought to the field to minimize the amount of decontamination procedures that need to be performed . SGS laboratory is responsible for preparing its equipment prior to delivery. All PUF cartridges will be cleaned, pre-weighed, numbered at the laboratory, and individually packaged before being shipped to the site under chain-of-custody. The list of necessary equipment is provided as Attachment 1 to this SOP.

The following steps are taken to set up the surface water collection system:

1. Assemble and secure the flow meter and primary pump to the weighted base mount.
2. Set up a clean area for the sampling equipment.
3. Attach a length of dedicated/new Teflon™ tubing to the primary pump, which will be secured to the base mounted pipe with flow sensor. The pipe with base mount, primary pump, flow sensor and tubing will then be lowered into the storm water pipe making sure the primary pump inlet does not come into contact with any accumulated sediment. The primary pump intake shall be pointed in the up-pipe direction within the water column. The outflow end of the main sample tube will be directed into the primary glass carboy (Note: The length of the Teflon™ tubing will vary depending on project-specific requirements and storm water manhole vault height at each given station).
4. Insert the intake end of the two lengths of Teflon™ sample tubing into the primary glass carboy.
5. Attach the two lengths of Teflon™ tubing (collecting end) to 30-cm platinum cured silicone™ tubing and a 1-m Teflon™ tubing, sequentially, and then connect the platinum cured silicone ™ part of these interconnected pieces of tubing firmly into place inside the large peristaltic pump head. The outlet tubing should be directed away from the storm water conveyance to ensure sampled water does not drain back into the outfall.
6. Secure the pumps and pump speed controllers and connect them to a generator or inverter with an extension cord. The generator should be positioned downwind from the sampling and should not be run while the PUF is being transferred to or from the sampler
7. Connect one of the Teflon™ tubes to a flow thru chamber to the whole water physical sample glass sample carboy and setup YSI Exo1 for water quality monitoring parameter logging.
8. Connect the other Teflon™ tube to the HVS intake tubing.

HVS Sample Collection

The following steps are taken to collect and process a standard HVS storm water sample:

1. Remove the protective cap from the sampling tube and insert fully into the primary glass carboy.
2. Switch the pump on and purge at least 3 tubing volumes of water through the tubing to ensure a representative sample is collected. During purge, calibrate pump flow rate to 1.5 L/min using a 1 L graduated cylinder.

3. Once purging is complete and flow rates are set, attach tubing outlet to vortex separator and pump storm water through the sample tubing into the vortex separator and through the PUF cartridge at a constant rate of approximately 1.5 L/min.
4. Every 15 minutes, record pump rate to ensure that the target rate of approximately 1.5 L/min is maintained. If the pump rate falls +/- 5% outside this range (i.e., outside of the range of 1.425 L/min to 1.575 L/min), adjust the speed of the pump.
5. Turn off the pump once the desired volume of storm water has been pumped through the PUF cartridge or the storm event ends.
6. Remove the PUF cartridge and cap each end with stainless steel nuts.
7. Remove the 0.45 micron flat filter and place in 8 oz. jar. If multiple flat filters are collected during the sample collection pumping these will be combined in the same 8oz jar for compositing at the testing laboratory.
8. Add the solids from the vortex separator into the flat filter 8 oz. jar by shutting the main line valve to the off position and opening the vortex outlet valve while running the pump for 10 seconds to purge the vortex separator. If needed, rinse the inside of the vortex separator with a squirt bottle filled with deionized water.
9. Attach sampling label, which contains the date, time, project name or number, sample ID, type of analysis required, and sampler initials per project planning documents (e.g. Quality Assurance Project Plan [QAPP])
10. Once the PUF cartridge and solids jar are properly closed and labeled, place them inside a cooler containing wet ice and store at approximately 6°C. All samples are to be stored in coolers with ice prior to submittal and/or shipping to the analytical laboratory, per project planning documents (e.g. QAPP)

Whole Water Sample Collection

The following steps are taken to collect the whole water storm water sample, in parallel with the HVS sample:

1. Remove the protective cap from the sampling tube and insert fully into the primary glass carboy.
2. Switch the pump on and purge at least 3 tubing volumes of water through the tubing to ensure a representative sample is collected.
3. Once purging is complete and flow rates are set, attach tubing outlet to the whole water dedicated carboy with an in-line flow-thru chamber connected to a YSI Exo multi-meter installed for measurement of Dissolved Oxygen, PH, turbidity, and temperature set to be recorded every 15 minutes.

4. Every 15 minutes, collect 1L of whole water into the secondary glass carboy. When not actively filling the carboy, this second tubing will be pumping to waste to maintain the constant pumping rate. The outlet tubing should be directed away from the storm water conveyance to ensure sampled water does not drain back into the outfall.
5. Turn off the pumps once the desired volume of storm water has been obtained or the storm event ends.
6. By reversing the peristaltic pump collect the TSS and TOC samples from the agitated secondary glass sample carboy into laboratory supplied sample containers, ensure the samples are properly sealed and labeled, place on wet ice and store at approximately 6°C.
7. Attach sampling label to the remaining whole water secondary glass sample carboy, which contains the date, time, project name or number, sample ID, type of analysis required, and sampler initials per project planning documents (e.g. Quality Assurance Project Plan [QAPP])
8. Once the carboy is properly sealed and labeled, place it on wet ice and store at approximately 6°C. All samples are to be stored on ice prior to submittal and/or shipping to the analytical laboratory, per project planning documents (e.g. QAPP).

Decontamination of HV Equipment

Dedicated sample tubing will be used at each sample location so decontamination will be unnecessary. Prior to sampling, the following steps are taken to decontaminate the HV water sampling equipment. The procedure specific to the high-volume sampling equipment is provided below.

1. Plumb decon silicone and Teflon tubing to the HVS system and whole water peristaltic pump
2. Pump 2 liters of Liquinox solution through PR2900 system
3. Pump 1 liter of DI water through the PR2900 system
4. Pump 1 liter of Methanol through PR2900 system
5. Pump 1 liter of DI water through PR2900 system
6. Pump 0.5 liter of Hexane through PR2900 system
7. Pump 1 liter of DI water through PR2900 system
8. Rinse the dedicated primary pump, primary glass carboy and secondary sample glass carboy with Liquinox
9. Rinse the dedicated primary pump, primary glass carboy and secondary sample glass carboy with DI

10. Rinse the dedicated primary pump, primary glass carboy and secondary sample glass carboy with Methanol
11. Rinse the dedicated primary pump, primary glass carboy and secondary sample glass carboy with DI
12. Rinse the dedicated primary pump, primary glass carboy and secondary sample glass carboy with Hexane
13. Rinse the dedicated primary pump, primary glass carboy and secondary sample glass carboy with DI
14. Cap all exposed inlets and outlets and wrap the primary pump with aluminum foil ready for sample collection

WATER QUALITY MEASUREMENTS

Physical and chemical water parameters will be collected at storm water stations. Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is frequently preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field if feasible). A YSI multimeter Exo1 with flow thru chamber will be used to log Dissolved Oxygen, pH, turbidity, and temperature parameters.

The YSI will run for the full duration of the sampling event to observe any potential changes in the physical parameters of the sample. The physical parameter data will be recorded every 15 minutes during sample pumping at each location.

Documentation of instrument information will adhere to project planning documents (e.g. FSP), and at a minimum will contain the name(s) of the person(s) making the measurement and the field equipment used to make that measurement must be recorded in the field logbook and on any field forms used during the sampling event. Equipment maintenance and calibration records must be kept in logbooks and field records so that the procedures are traceable. All field records will be checked by field staff for completeness and electronically provided to the Client.

STORMWATER FLOW MEASUREMENT

A Greyline Stingray 2.0 flow sensor (or equivalent) will also be incorporated into the sampling program to measure flow and volume. The flow sensor transmits ultrasonic pulses that travel through the water and reflect off the liquid surface. To monitor water level, the Stingray 2.0 precisely measures the time it takes for echoes to return to the sensor. Velocity is measured with an ultrasonic signal continuously injected into the flow. This high frequency sound is reflected back to the sensor from particles or bubbles suspended in the liquid. If the fluid is in motion, the echoes return at an altered frequency proportionate to flow velocity. The Stingray 2.0 uses this Doppler frequency shift to accurately calculate flow velocity. The Stingray will be attached to the base plate of the pole used to deploy the sampling tube.

The Stingray will run for the full duration of the sampling event to observe any potential changes in the flow. The flow sensor Greyline Logger software will display and record near continuous log files and flow rates in graph and table formats. Flow data reports including minimum, maximum and average flow, and calculated flow totals will be generated.

SAMPLE HANDLING

Standard "clean and dirty hand" techniques will be observed on this project. Clean hands are required for sample collection and handling, as described above. Field staff will wear appropriate non-contaminating, disposable, powderless nitrile gloves during the entire sampling operation. Gloves will be changed frequently, usually with each change in task (wearing multiple layers of gloves allows rapid glove changes).

Clean hands are required for all operations that involve equipment that comes into contact with the sample, including the following activities:

- Handling the PUF column, 0.45 micron flat filter and vortex separator vial
- Handling the intake end of the sample tube or line
- Setting up working space inside the processing chambers
- Setting up the equipment (i.e., high volume sampler and PUF cartridges) inside the chambers
- Handling the vortex separator
- Changing the chamber covers as needed.

Dirty Hands take care of all operations that involve contact with potential sources of contamination, including the following activities:

- Working exclusively exterior to the processing and preservation chambers
- Preparing a clean workspace (inside boat)
- Preparing and operating the sampling equipment, including the pumps and discrete samplers
- Handling the generator or other power supply for samplers
- Handling the tools, such as hammers, wrenches, keys, locks, and sample-flow manifolds
- Handling the single or multi-parameter instruments for field measurements

- Setting up and checking the field-measurement instruments
- Measuring and recording the water depths and field measurements.

All samples are stored in coolers with ice at approximately 6°C until transferred to the laboratory at the conclusion of the sampling day or the following day. The sampling team leader is responsible for maintaining sample integrity throughout the sampling event.

Sample contamination will be avoided by handling the sample containers with clean gloves, and transferring the samples into clean refrigerators (or clean coolers) immediately after samples have been brought back from the field. Sample bottles will always be handled by personnel wearing disposable, powderless nitrile gloves. This includes any and all sample handling that may occur during sample packing and shipping.

REFERENCES

David, N., D. Bell, and J. Gold. 2001. Field sampling manual for the Regional Monitoring Program for Trace Substances. San Francisco Estuarine Institute, San Francisco, CA.

USEPA. 1996. Method 1669 - Sampling ambient water for trace metals at EPA water quality criteria levels. U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303). Washington, DC.

USGS. [various dates]. National field manual for the collection of water-quality data: U.S. Geological Survey techniques of water-resources investigations, Book 9, Chap. A1-A9. Available online at http://pubs.water.usgs.gov/twri9A. U.S. Geological Survey. Accessed February 5, 2008, at http://water.usgs.gov/owq/FieldManual/index.html#Citation.

ATTACHMENT 1. FIELD EQUIPMENT LIST

- High volume peristaltic pump with vortex separator
- Primary in-line pump
- Secondary peristaltic pump
- teflon® tubing
- Primary glass carboy
- Secondary glass sample carboy
- YSI Exo1 water parameter multi-meter capable of measuring pH, reduction/oxidation (redox) potential, temperature, specific conductance, turbidity, and dissolved oxygen
- Greyline Stingray 2.0 flow sensor or equivalent
- Teflon-lined polyethylene sample tubing (length is site dependent)
- Platinum cured silicone tubing
- Plastic zip-ties
- Water Sampling Log forms
- Sample tags/labels and appropriate documentation (e.g., chain-of-custody forms)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample containers (PUF cartridges, vortex separator vials)
- Coolers
- Wet ice
- Nitrile gloves
- First aid kit
- Eye wash kit
- Duct tape
- Clear tape
- Packing tape dispenser
- Tool box
- Coated weights for water samplers
- Non-metallic wire for winch spool
- 2000 watt power generator or inverter
- Paper towels
- Dilute solution of Liquinox
- Deionized water
- Extension cord
- Power strip
- Resealable plastic bags (i.e., 1 gallon and 1 quart)
- Methanol
- Hexane
- 0.45 micron flat filters

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SOP A-6, SIB Project Area, PHSS
(Source: In-Line Sediment Trap)

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1. PURPOSE AND SCOPE

The following text describes the techniques that will be employed to collect in-line sediments at locations identified in the Pre-Design Investigation (PDI) Work Plan.

2. EQUIPMENT

To assess incoming contaminant loads and movement of settleable suspended solids, in-line sediment traps will be deployed and sampled. In-line sediment traps will be installed and retrieved in select locations as described in the PDI Work Plan.

In-line sediment traps addressed by this SOP include the deployment of four 1-Liter HDPE sample bottles held in place with a custom stainless-steel bracket. At each designated sampling location, in-line sediment traps will be installed at the bottom of the conveyance system. In-line sediment traps will be firmly secured to the conveyance system to prevent unintended transport of the equipment. All in-line sediment traps and related equipment will be decontaminated prior to installation.

The HGL Confined Space Entry SOP will be followed by certified contractors entering manholes.

3. DEPLOYMENT OF SEDIMENT TRAPS

As identified in the PDI Work Plan, in-line sediment trap structures will be installed (Figure 1). Field crews with confined space entry training will perform a confined space entry in accordance with HGL Confined Space Entry SOP to install the sediment traps in the flow. A confined space entry will also be required to collect the sediment samples. Each of the 1-liter HDPE sample bottles with removeable Teflon®-lined lids will be held to the bottom of the pipe using custom stainless-steel hardware and brackets (Figure 2).

Sediment traps will be deployed at each location and the sample bottles will be retrieved at the intervals described in the PDI WP. When samples bottles are collected and archived, a clean bottle will be installed in the trap. Sediment samples will be capped, labeled, sealed, and submitted to the laboratory in accordance with the appropriate project planning documents. In general, procedures detailed in this SOP are adopted from the approved Portland Harbor RI/FS Stormwater Field Sampling Plan (LWG 2007; Appendix C).

Figure 1. Schematic of deployed Boston sediment trap.

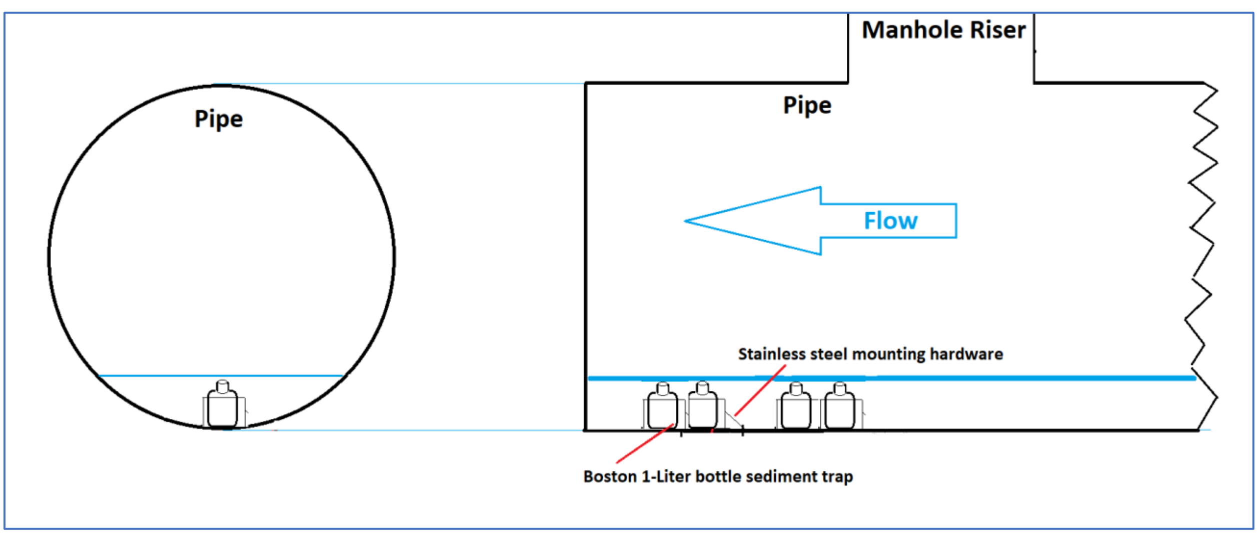

Figure 2. Installation photograph of example deployed sediment traps.

4. INSTALLATION METHODS

Experienced field personnel will install the in-line sediment traps using stainless steel hardware and using inert materials. A confined space entry will be required to install the in-line sediment traps. Where traffic controls are required, a traffic control permit will be obtained from the City of Portland. An encroachment permit from the City may also be required to install the in-line sediment traps.

When installing the brackets in the field at the sampling sites, field crews will clean the area around the stainless-steel anchor bolts to remove any concrete dust or debris. After the bolts are set or other procedures are complete, the work site will be scrubbed with a brush to remove any debris and rinsed with deionized water before the sampling hardware (sample bottle holder) is mounted. Care will be taken to capture the rinse water from the work area.

5. LIST OF EQUIPMENT NEEDED FOR IN-LINE SEDIMENT TRAP SAMPLING

The following equipment and supplies will be used for sediment sample collection:

- Photoionization detectors (PIDs)
- Confined space entry and personnel retrieval equipment
- Laboratory-supplied 1-Liter sample bottles
- Decontamination kit (buckets, brushes, Alconox, and tap and deionized water)
- Camera
- Sharpies/pens
- Labels
- Chain-of-Custody forms
- Ice and cooler
- Paper towels
- Personal protective equipment (PPE), including hard hat, boots, safety glasses, high-visibility vest, nitrile gloves, and ear plugs for drilling activities
- Confined space entry PPE.

6. SEDIMENT RETRIEVAL METHODS

In accordance with the PDI WP, the sediment traps will be collected and archived in the analytical laboratory and a clean bottle will be installed to the trap bracket. The methods for retrieving the accumulated sediment are presented below. A confined space entry will be performed to retrieve sediment samples according to these instructions:

- Using safe lifting techniques, traffic controls (if needed), and implementing all health and safety protocols, open the manhole cover.
- Perform the confined space entry into the manhole and prepare to retrieve the sediment trap bottles.
- Implement “clean hands – dirty hands” method (EPA 1996; Attachment B) for collecting samples.
- Use phthalate-free vinyl gloves to place the Teflon lids on the sample bottles.
- Remove the sample bottle from the bracket and transfer each bottle to the surface.
- Label the bottle, pack on ice, and prepare for transport to the analytical laboratory.
- Place new laboratory-provided 1-Liter sample bottles back into the brackets, remove the lids, and store the lids in a phthalate-free bag.
- Exit the confined space and replace the manhole cover.

7. DECONTAMINATION PROCEDURES

Decontamination of sampling equipment must be conducted consistently to ensure the quality of samples collected. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

Decontamination will occur prior to each use of a piece of equipment. All sampling devices that potentially contact sampling media (grab pole, stainless beaker, cups, etc.) will be decontaminated according to EPA Region 10 recommended procedures. The following, to be carried out in sequence, is an EPA Region 10 recommended procedure for the decontamination of sampling equipment:

- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap water rinse
- Deionized/distilled water rinse (first rinse)
- Deionized/distilled water rinse (second rinse)

Equipment will be decontaminated in a predesignated area, and clean bulky equipment items will be stored in their cases or on visqueen in uncontaminated areas. Cleaned small equipment items will be stored in their cases or in plastic bags. Materials to be stored more than a few hours will also be covered.

8. FIELD FORMS

During each site visit to retrieve accumulated sediment, the field crews will complete a field form which will record the following information:

- Name of staff conducting downloading
- Location
- Date/time of sampling
- Approximate volume of sediment sampled
- Condition of the sediment traps
- General comments/observations

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SOP A-7, SIB Project Area, PHSS
(Source: Horizontal and Vertical Control)

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STANDARD OPERATING PROCEDURE
HORIZONTAL AND VERTICAL SURVEY CONTROL

Introduction

This Standard Operating Procedure (SOP) has been developed for the Pre-Remedial Design Sampling and Baseline Investigations (PDI) at the Portland Harbor Superfund Site located in Portland, Oregon to confirm accurate positioning of vessels and samples during sample collection activities. The survey control requirements described in this SOP are specifically for environmental sample collection and will generally comply with map-grade precision and accuracy in contrast to the geodetic-grade precision and accuracy performed for the Bathymetric Survey conducted by David Evans and Associates (DEA). However, the same survey control points and geodetic parameters will be used in both surveys for consistency, and a portion of the quality assurance/quality control (QA/QC) process will involve consultation with DEA Oregon Professional Land Surveyor (PLS) staff to review the map-grade data collected for the environmental sample collection.

The organization of this SOP is as follows:

- Methodology Overview
- Project Geodetic Parameters
- Survey Accuracy, Precision, and Control
- Primary Equipment
- Hand-Held GPS Operation
- Vessel Navigation and Equipment Operation
- Data Processing and QA/QC Procedures

Tables, figures, and attachments are presented at the end of the SOP.

Methodology Overview

Horizontal (Map) Data Collection

A combination of vessel-mounted and hand-held GPS receivers will be used to navigate to sampling locations and to collect map location coordinates (Northings, Eastings) for those sampling locations. The vessel-mounted GPS receivers will be the primary tool used for navigation to the pre-planned sampling locations in a GIS file, which will be pre-loaded into the vessel navigational system. The hand-held GPS devices will be used as a backup and confirmation of vessel position only if there are problems with the vessel GPS navigation system or if there is no specific vessel navigation system (i.e., smaller boats). Since the inception of field work, the vessel GPS coordinates have been consistently verified and deemed to be sufficient to meet position and accuracy requirements for the project. The hand-held GPS devices will primarily be used for studies involving small vessels. These devices will also have the pre-loaded basemap content depicting planned sampling locations.

The vessel GPS will operate in two modes, collecting both a separate continuous data stream of positional information (line file) and recording GPS soundings (target file) when a sample is specifically collected. The sample location target file will be recorded when the sampling device is in position for the grab (e.g., when sampler is on the river bottom). The specific Location ID associated with the sample will also be recorded in the GPS device log. Field personnel will be required to write that same Location ID on their field data collection forms at the same time. Both the continuous and episodic dataset will be timestamped to allow comparison of the two types of data. This data will be recorded and maintained on the vessel, and will also be exported from the vessel navigation system and archived to project servers on a daily basis.

The hand-held GPS devices will be operated independently of the vessel's systems and will be used to record a location sounding wherever a sample is collected only for studies unable to use the vessel GPS navigation system. The sample location sounding will be recorded approximately at the same time as when the vessel GPS measurement is collected (e.g., when sampler is in position). The specific Location ID associated with the sample will also be recorded on the GPS device. Field personnel will write this Location ID on the field forms only if the vessel measurement described earlier cannot be collected for some reason (e.g., equipment failure). These measurements will also be timestamped. The data from the hand-held GPS devices will be wirelessly synchronized to a "cloud" web service in near real-time; the data from the "cloud" will also downloaded and saved to project servers daily.

Vertical Data Collection

Vertical (elevation) data is also required for water levels, sample collection depth below surface water, and bottom (mudline) depth location for some types of sample locations. For increased precision and accuracy, it is proposed that bottom (mudline) depth locations (e.g., for sediment cores) be calculated from the bathymetric surface to be developed by the hydrographic survey performed by DEA (since the data will be collected within a few months of each other). The NAVD88 elevation will be calculated from the intersection of the surface map location coordinates collected as described earlier, projected vertically down to the bathymetric surface (United States Army Corps of Engineers [USACE], 2004). The elevation from the intersection of the bathymetric surface will be used as the final or "best" elevation for the sample.

In contrast, for depth measurements that require less precision (e.g., water levels, depth to samples below water surface), the onboard vessel sonar will be used to record depth and then subsequently calculate elevation. All depths will be recorded relative to the water surface and time tagged to correct with time tagged gauge data for obtaining riverbed elevations. The elevation will be calculated to NAVD88 datum. To correct elevations, gauge data from the Northwest River Forecast Center will be downloaded for gauge PRT03, which is representative of the former Morrison gauge which has been moved. This gauge does not report NAVD88 elevations but rather reports a value that is 0.3 feet above Columbia River Datum (CRD). Corrections from CRD to NAVD88 differ moving down the river from the gauge due to the fact that NAVD88 is a reference normal to gravity (water does not flow if the elevation is unchanging), and CRD is a gradient datum that follows the lower water surface. In Portland Harbor, the difference between CRD and NAVD88 (Geoid12b) ranges from 0.00 feet CRD = -5.16 feet NAVD88 (Geoid12b) at Willamette River river mile (RM) 2.0, to 0.00 feet CRD = -5.41 feet NAVD88 (Geoid12b) at Willamette River RM 12.8 (approximate location of PRT03 Gauge). Accordingly, a correction to the Willamette Gauge in Portland would be -5.41+0.3 or -5.11 feet at RM 12.8. An approximation would be to subtract 5 feet from the gauge reading for the full length of the study area, but precision will vary depending on tides and river gradient.

For sample locations requiring vertical information, depth will be recorded by field staff on their data collection forms relative to the water surface, and these values will be loaded to the project database as described in the Data Quality Management Plan (DQMP). Final calculated NAVD88 elevation data (feet) will also be entered into a separate data field in the project database after completion of spatial analysis, calculations, and QA/QC. DEA will provide support during the QA/QC process to verify proper calculation of NAVD88 elevation data.

Location Position Recording in Project Database

Discrete Samples

When discrete samples are collected, the Location ID and the location coordinates (Northing/Easting) will be recorded on the GPS device(s) and the field data collection form(s). The location coordinates will be based on the vessel GPS instantaneous target measurement. This target measurement will be the location coordinate pair loaded initially to the project database. After the field event is completed, the target measurement will be compared to the line file (vessel continuous GPS measurement) to confirm that the coordinate pair loaded to the project database is appropriate. If analysis reveals precision or accuracy issues, the loaded location coordinate pair in the project database may be updated and edited with a better value derived from the line file. In general, the hand-held GPS devices will be used as a backup and confirmation of vessel position only if there are problems with the vessel GPS navigation system or an independent navigation system is not available on the vessel. These coordinates will be loaded to the project database only if there is a significant problem with the vessel GPS (e.g., equipment failure) or if there is no vessel GPS.

Composite Samples

When composite samples are collected, location coordinates will also be recorded as both target measurements and continuous measurements using the vessel GPS. The continuous GPS measurements will be recorded during the entire compositing event, and instantaneous target measurements will be collected when the sampler is in position for each individual composite grab. At each compositing location, a target measurement will be recorded in the vessel GPS along with the Location ID with an "a," "b," or "c" suffix. These measurements will be recorded on the field forms in the same manner (e.g., there will be three sets of location coordinates, lithologic descriptions, etc.).

When the location data is loaded to the project database, a single set of location coordinates will be recorded in the project database with a Location ID that excludes the "a," "b," or "c" suffix. As a presumed middle time point, the "b" set of coordinates will be loaded with the primary Location ID to the project database. After the field event is completed, the target measurement associated with the "b" location composite will be compared to the line file (vessel continuous GPS measurement) to assess vessel position and the timeframe of the entire sampling event to confirm if the coordinate pair loaded to the project database is appropriate. The goal will be to finalize the location coordinate information in the project database based on the most representative position based on this analysis. Similar to discrete sample collection, a hand-held GPS device and related data will only be loaded to the project database if there is a significant problem with operation of the vessel GPS or if the vessel does not have a GPS.

Finally, after field data are collected and surveys are completed, as defined in the DQMP, the location coordinate data will be joined with the tabular data collected by the field teams and loaded to the project database.

Project Geodetic Parameters

The geodetic parameters to be used for the PDI field studies will be as follows:

Horizontal Datum: North American Datum of 1983 (2011)
Projection: State Plane Coordinate System (SPCS) Oregon North Zone
Vertical Datum: North American Vertical Datum of 1988 (NAVD88) Geoid12b
Units: International Feet

Survey Accuracy, Precision, and Control

The anticipated horizontal accuracy of environmental sampling associated with vessel and hand-held GPS devices is a range of 1 to 5 meters (target 1 to 2 meters for the DGPS unit itself). This should be consistent with RI target accuracy (Integral 2002) and best practices (Puget Sound Estuary Protocols [PSEP] 1998 and US Environmental Protection Agency [EPA] 2008).

The anticipated vertical accuracy of final elevation calculations derived from vessel sonar systems is anticipated to be 1.0 meter.

Table 1 summarizes the survey control locations used in the DEA Bathymetric Survey, which will be used for the environment sample collection work described in this SOP. Figure 1 shows the PH2 piling at Fred Devine boat dock, and Figure 2 shows the approximate locations of the survey control references. Attachment 1 contains detailed survey sheets of the control points: Raindeer, PH1 and PH2, and 2100.

Primary Equipment

- Trimble® SPS 461 GPS with dual antennas (vessel GPS)
- A-frame assembly, sampling winch (vessel boom)
- Trimble® R1 (hand held GPS), tethered to Bluetooth® capable smartphone or tablet, ESRI Collector software with Trimble® GNSS Status middleware
- GPS owner's manual
- Writing tools (pencils, Sharpie®)
- Field logbook
- Spare batteries and/or battery charger
- Compass
- Tape measure

Hand-Held GPS Operations

For ease of use, the project team will utilize smartphones tethered to the Trimble® R1 GNSS Receiver via a Bluetooth® connection. The smartphone will be configured with Trimble's middleware software called GNSS Status to convert and stream NMEA satellite data to the smartphone for real-time correction and display to a simple electronic data collection form developed on the ESRI Collector platform. The form will contain a limited number of data fields, including location, study name and operator, date, and notes or comments. This form is not intended to duplicate the content and scope of the field data collection forms, but rather clearly link the GPS data to those forms via the unique Location ID. There are metadata fields available as well from these GPS records, such as estimated horizontal accuracy.

Collected data recorded onto the phone will be transmitted wirelessly via a synchronization process invoked when data is “saved” to the device. The data will be pushed to AECOM Online’s Portal and ArcGIS Server for storage of “corrected” location coordinates, Location ID, and other information captured when the GPS sounding is recorded. The sampling event will be trackable in near-real-time as samples are collected on the ArcGIS Portal Interface. Either dedicated, experienced GPS-operators will be collecting the measurements on the smartphones, or, due to the very simple nature of the interface, field personnel will be trained to use the devices. Initial training sessions were already successfully conducted March 19-20, 2018 on use of the smartphone GPS interface. These handheld devices were successfully used for the first 2 weeks of field work. For some studies, such as the smallmouth bass tracking study, these handhelds may be used as the primary GPS due to smaller vessel configuration.

Vessel Navigation and Equipment Operation

Vessel positioning will be conducted through the marine navigation and hydrographic software package HYPACK. This software package allows the visualization of the vessel over navigable charts, the processing of satellite corrections, stored hardware, and vessel parameters, as well as the storing of physical target locations during sampling activities. HYPACK version 2017 will be used for this project.

Vessel position is measured using a Trimble SPS 461 GPS dual antenna receiver. The dual antennas provide precise vessel positioning via both satellite and differential radio corrections along with heading correction to 0.09 degree. GPS data is output through a serial connection into computer running the HYPACK software, for vessel positioning and target collection.

At each sampling location, depth to mudline will be measured using an onboard fathometer (with lead line as confirmation as needed) immediately prior to or during the sampling. Water depths are measured at each station using an Airmar ss510 survey sonar at the sampling point and confirmed daily with a lead line with reference to water surface. Vertical measurements will be recorded to the nearest 0.1 foot. Water depths will be converted to elevations in NAVD88 based on the river stage at the time of sampling as recorded at the closest available tide gage.

Data Processing and QA/QC Procedures

All GPS devices will be subject to a position check to confirm the accuracy of the on-vessel GPS and hand-held GPS devices and to validate the positions derived from each GPS receiver. Correctors being applied as needed, resulting in a position that is within specified positioning accuracy of the DEA published position for control monument PH1 and PH2. At the start and end of each field day, the PH2 benchmark location will be visited by boat to perform a position check. At the piling serving as the control monument, the on-vessel GPS calibrated to the top of A-frame assembly will be maneuvered as close to the benchmark piling as possible to record a point. The GPS-derived position of the sampling vessel is compared with the known horizontal location; results will be recorded in HYPACK to confirm that accuracy is within +/- 2 meters. For handheld GPS, field staff will occupy the PH1 at the Swan Island boat launch parking lot. Using the R1 and phone/tablet combination GPS setup, the field staff will hold the R1 above PH1 and wait for a satellite “fix,” and when ready, the staff will record the GPS location in Collector. This GPS location will be compared to the known coordinates to confirm the accuracy is within +/- 2 meters. The survey control monuments act as a known location to allow for corrected station location coordinates during post-processing of data as needed. If a need arises to locate another benchmark, there are several USGS control points near the project area and near the AECOM project warehouse. Experienced GPS operators on the project team will be involved in all aspects of field data collection events to troubleshoot devices and assist in daily review of extracted geospatial datasets. Additional details on QA/QC procedures can be found on the DQMP.

References

AECOM (AECOM Technical Services) and Geosyntec (Geosyntec Consultants, Inc.). 2018. Data Quality Management Plan Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling. Portland Harbor Superfund Site. 22 February.

Integral (Integral Consulting). 2002. Round 1 Field Sampling Plan. Prepared for the Lower Willamette Group (LWG) for submittal and approval by EPA Region 10. June 14.

EPA (United States Environmental Protection Agency). 2008. National Geospatial Data Policy. August 24.

PSEP. 1998. Recommended Guidelines for Station Positioning in Puget Sound. Prepared for United States EPA Region 10 and the Puget Sound Water Quality Action Team. September.

USACE (United States Army Corps of Engineers). 2004. Engineering and Design Hydrographic Surveying Manual, EM 1110-2-1003, U.S. Army Corps of Engineers, April 2004

Attachments

PH Control Points of 2100, Portland Harbor (PH1 and PH2), and Raindeer survey monuments, as well as figures presenting PH2.

Table 1. Benchmark Monument Coordinates and Description

Designation	Approx. Location	Description	NAD83 (2011), Oregon SPCS North (ft)		NAVD88 Elevation (ft)
			Northing	Easting	
DEMSI-BASE	Columbia River	Fixed antenna with height at antenna reference point	718172.70	7654431.05	73.58
DEMSI- CHECK	Columbia River	Fixed antenna with height at antenna reference point	718170.73	7654419.84	71.67
RAINDEER	RM 2	USACE Brass Cap	722443.24	7614886.64	35.44
Portland Harbor (PH1)	Swan Island Boat Ramp	1/2" Iron Rod with red plastic cap stamped "DEA Control" Point is 0.3 feet south of the back of curb at the Swan Island Boat Ramp, 10.5 feet north of a cyclone fence, and 60 feet east of a light post	698702.46	7637426.37	33.38
Portland Harbor 2 (PH2)	Fred Devine Boat Dock	Reference point is 0.2 feet SE of the SE side of a 1-1/2 foot steel pile. This is the furthest SE pile at the end of the Fred Devine Diving and Salvage Company dock in the Swan Island Lagoon. This pile is to be used for daily position checks for sediment sampling operations. Pile is for position only and not elevation.	700967.87	7634507.67	NA
2100	RM 13	5/8" bolt on SW corner of screen wall at DEA office 2100 SW River Parkway, Portland, OR	678400.01	7645190.81	159.51

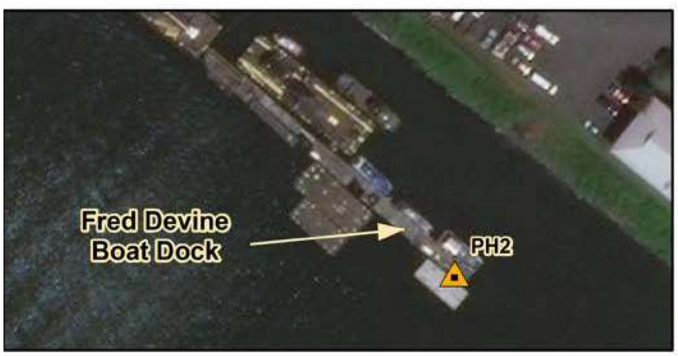
General Notes:

1. The two DEMSI and the 2100 stations are transceiver beacon stations in upland areas (Green Shade).
2. PH1 is located at the Swan Island boat ramp parking lot and accessible by foot.
3. PH2 is located at a piling at the boat dock where project-related vessels will be docked and is accessible by boat.
4. Raindeer station is located adjacent to the river and accessible by foot (for the hand-held GPS).

Acronyms:

DEA = David Evans and Associates; ft = feet; NAD83 = North American Datum of 1983; NAVD88 = North American Vertical Datum of 1988; PH = Portland Harbor; RM = river mile; USACE = US Army Corps of Engineers; SPCS = State Plane Coordinate System

Figure 1. Photograph of Piling PH2, at the end of the Fred Devine Boat Dock. Piling was captured in DEA bathymetric survey. Photo is facing northwest.



PH2 is located on the SE corner of the Fred Devine Boat Dock, where Gravity's boats berth every night.

PH1 is located on the SW side of the Swan Island Boat Launch parking lot, where field crews park to meet the boats at the launch dock.

Figure 2. Locations of control monuments PH1 and PH2 at Swan Island Boat Launch and Fred Devine Boat Dock, respectively.

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

GPS STATION OBSERVATION LOG April 16, 2003	Station Designation: (check applicable:__ FBN__ CBN__ PAC__ SAC __BM) 2100	Station PID, if any:	Date (UTC): 06-Mar-18
	General Location: DEA Office 2100 SW River Parkway, Portland Airport ID, if any:	Station 4-Character ID:	Day of Year: 065
Project Name: Portland Harbor - AETR00000034	Project Number: GPS-	Station Serial # (SSN):	Session ID:(A,B,C etc)

NAD83 Latitude ° ' "	NAD83 Longitude ° ' "	NAD83 Ellipsoidal Height meters	Agency Full Name: David Evans and Associates, Inc.
Observation Session Times (UTC): Sched. Start ________ Stop ________ Actual Start 18:55 Stop 23:00	Epoch Interval= 1 Seconds Elevation Mask = 10 Degrees	NAVD88 Orthometric Ht. meters GEOID99 Geoid Height meters	Operator Full Name: David T. Moehl Phone #: ( ) (360) 314-3200 e-mail address: dtm@deainc.com

Receiver Brand & Model: Trimble SPS855
P/N: 69855-60
S/N: 5506R0075
Firmware Version: 5.30
❒ CamCorder Battery, ❒ 12V DC, ☑ 110V AC, ❒ Other

Antenna Code*, Brand & Model: Trimble Zephyr 3 Base
P/N: 115000-10
S/N: 3121179869
Cable Length, meters: 10
Vehicle is Parked n/a meters ____(direction) from antenna.

	Circle Yes or No
Antenna plumb before session?	(✓/ N)
Antenna plumb after session?	(✓/ N)
Antenna oriented to true North?	(Y / N✓)
Weather observed at antenna ht.	(Y / N✓)
Antenna ground plane used?	(Y / N✓)
-If no, explain "	
Antenna radome used?	(Y / N✓)
Eccentric occupation (>0.5 mm)?	(Y / N✓)
Any obstructions above 10°?	(Y / N✓)
Radio interference source nearby	(Y / N✓)
If yes, describe. Use Vis. form	

Tripod or Antenna Mount: Check one:
❒ Fixed-Leg Tripod, ❒ Collapsible-leg tripod ☑ Fixed Mount
Brand & Model: Bolt
P/N:
S/N:
Last Adjustment date:

Psychrometer (if used) Brand & Model:
P/N:
S/N:
Last Calibration or check Date:

** ANTENNA HEIGHT **	Before Session Begins: Meters	Feet	After Session Ends: Meters	Feet
A= Datum point to Top of Tripod (Tripod Height)	0.000		0.000	
B=Additional offset to ARP if any (Tribrach/Spacer)	0.000		0.000	
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)	0.000	0.00	0.000	0.00

Meters = Feet x (0.3048)
Height Entered Into Receiver = 0.000 meters.
Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model:
S/N:

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Dry-Bulb Temp Celsius	WetBulb Temp Fahrenheit	WetBulb Temp Celsius	Rel. % Humidity	Atm. Pressure inches Hg	Atm. Pressure millibar
Before	00000	18:55							
Middle									
After	00000	23:00							

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

5/8" bolt found on the southeast corner of the VAC screen wall on DEA office roof at 2100 SW River Parkway, Portland, OR. The geodetic antenna was screwed tight to the top of the double nut on the 5/8" bolt. The antenna height = zero to the antenna reference point (bottom of antenna mount).

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s): 00750650.T02
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

Updated Station Description:	❒ Attached	❒ Submitted earlier
Visibility Obstruction Form:	❒ Attached	❒ Submitted earlier
Photographs of Station:	☑ Attached	❒ Submitted earlier
Pencil Rubbing of Mark:	❒ Attached	

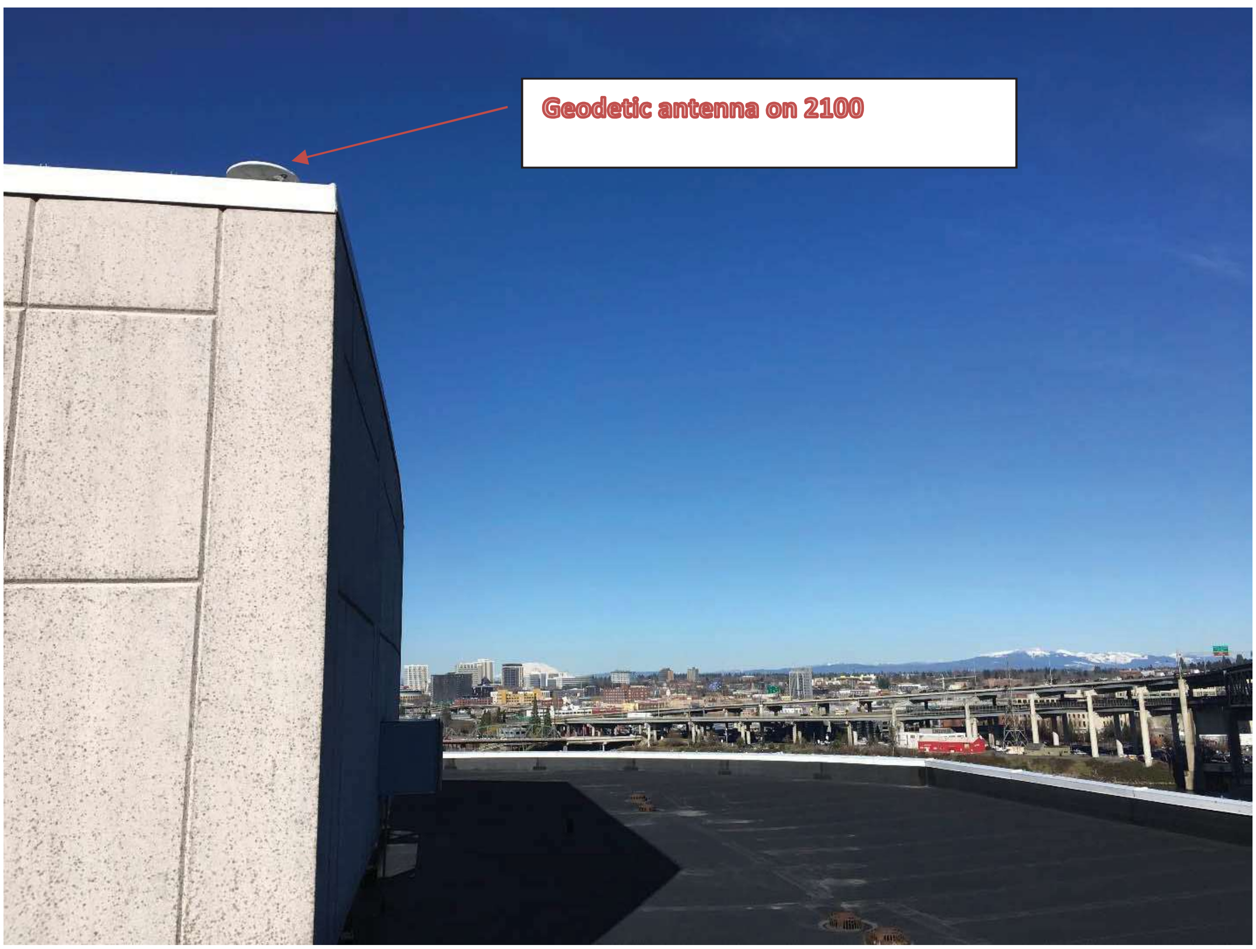
LOG CHECKED BY: Jon Dasler

Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)
Examples:	00000 = No problem, good visibility, normal temp, clear, calm wind			12121 = Problems, poor visibility, hot, overcast, moderate wind		

Photo of Monument 2100

Photo of Monument 2100

GNSS Setup on 2100



NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

GPS STATION OBSERVATION LOG
April 16, 2003

Station Designation: (check applicable:__ FBN__ CBN__ PAC__ SAC __BM)
Portland Harbor 1 (PH1)

Station PID, if any:

Date (UTC): 06-Mar-18

General Location: Swan Island Boat Launch

Airport ID, if any:

Station 4-Character ID:

Day of Year: 065

Project Name: Portland Harbor - AETR00000034

Project Number: GPS-

Station Serial # (SSN):

Session ID:(A,B,C etc)

NAD83 Latitude o ' "

NAD83 Longitude o ' "

NAD83 Ellipsoidal Height meters

NAVD88 Orthometric Ht. meters

GEOID99 Geoid Height meters

Agency Full Name: David Evans and Associate, Inc.

Operator Full Name: David T. Moehl

Phone #: ( ) (360) 314-3200

e-mail address: dtm@deainc.com

Observation Session Times (UTC):
Sched. Start ________ Stop ________
Actual Start 19:30 Stop 21:32

Epoch Interval= 1 Seconds
Elevation Mask = 10 Degrees

Receiver Brand & Model: Trimble SPS985
82500-60
P/N:
S/N: 5616F59510
Firmware Version: 5.30
❒ CamCorder Battery, ❒ 12V DC, ❒ 110V AC, ✓ Other

Antenna Code*, Brand & Model: Trimble SPS985 Internal
P/N:
S/N:
Cable Length, meters: n/a
Vehicle is Parked 10 meters N (direction) from antenna.

Antenna plumb before session?	(✓/ N)	Circle Yes or No -If no, explain
Antenna plumb after session?	(✓/ N)	
Antenna oriented to true North?	(Y / N✓)	
Weather observed at antenna ht.	(Y / N✓)	
Antenna ground plane used?	(Y / N✓)	"
Antenna radome used?	(Y / N✓)	If yes, describe. Use Vis. form
Eccentric occupation (>0.5 mm)?	(Y / N✓)	
Any obstructions above 10°?	(Y / N✓)	
Radio interference source nearby	(Y / N✓)	

Tripod or Antenna Mount: Check one:
✓ Fixed-Leg Tripod, ❒ Collapsible-leg tripod ❒ Fixed Mount
Brand & Model: Seco fixed height
P/N:
S/N: 5115-00-FLY
Last Adjustment date: 2018-03-05

Psychrometer (if used) Brand & Model:
P/N:
S/N:
Last Calibration or check Date:

** ANTENNA HEIGHT **	Before Session Begins: Meters	Before Session Begins: Feet	After Session Ends: Meters	After Session Ends: Feet
A= Datum point to Top of Tripod (Tripod Height)	2.000		2.000	
B=Additional offset to ARP if any (Tribrach/Spacer)	0.000		0.000	
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)	2.000	6.56	2.000	6.56

Meters = Feet x (0.3048)
Height Entered Into Receiver = 2.000 meters.
Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model:
S/N:

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Dry-Bulb Temp Celsius	WetBulb Temp Fahrenheit	WetBulb Temp Celsius	Rel. % Humidity	Atm. Pressure inches Hg	Atm. Pressure millibar
Before	00000	19:30							
Middle									
After	00000	21:32							

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Control point is a 1/2" iron rod with red plastic cap stamped "DEA CONTROL" set 0.1' below natural grade. Control point is 0.3' south of the back of curb, 10.5' north of a cyclone fence and 60' easterly of the 2nd light post east of the boat ramp. See detached sketch and photos.

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s): 95100650.T02
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

Updated Station Description: ❒ Attached ❒ Submitted earlier
Visibility Obstruction Form: ❒ Attached ❒ Submitted earlier
Photographs of Station: ✓ Attached ❒ Submitted earlier
Pencil Rubbing of Mark: ❒ Attached

LOG CHECKED BY: Jon Dasler

Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)

Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind

Sketch of Monument PH1

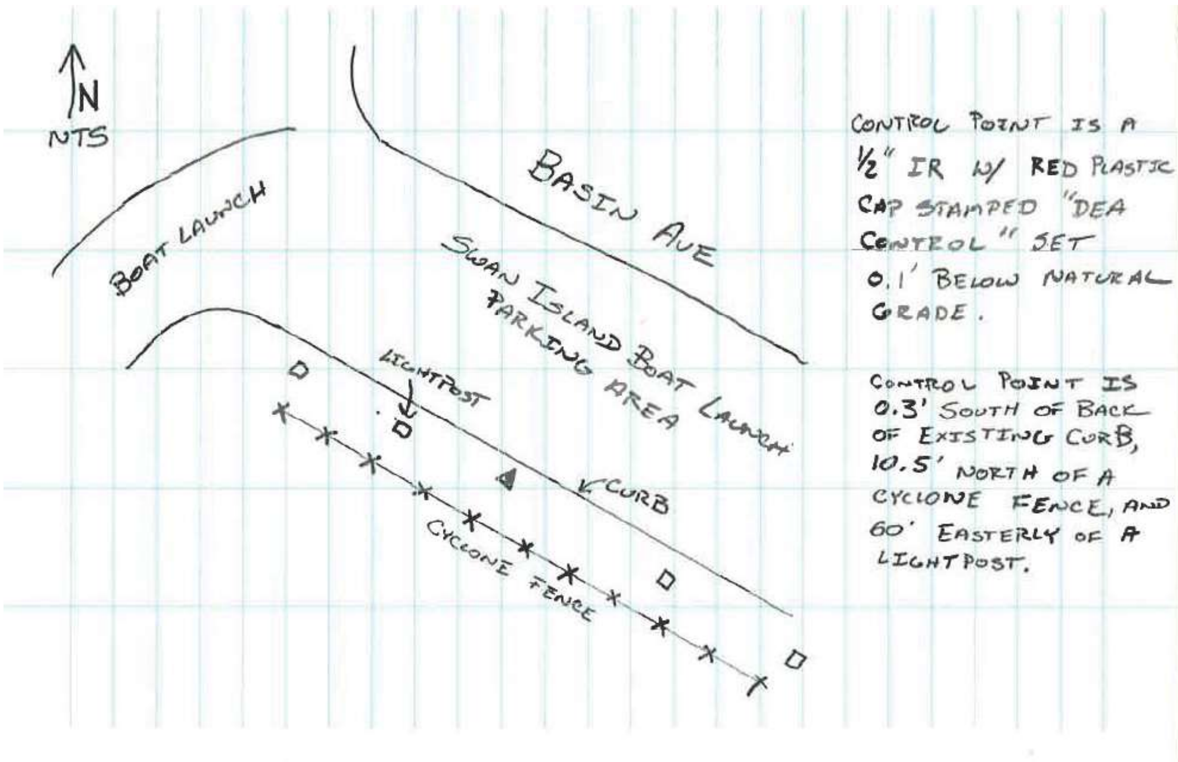


Photo of Monument PH1

GNSS Setup on PH1

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

GPS STATION OBSERVATION LOG
April 16, 2003

Station Designation: (check applicable:__ FBN__ CBN__ PAC__ SAC __BM) Portland Harbor 2 (PH2)		Station PID, if any:	Date (UTC): 20-Apr-18
General Location: Fred Devine Boat Dock	Airport ID, if any:	Station 4-Character ID:	Day of Year: 111
Project Name: Portland Harbor - AETR00000034	Project Number: GPS-	Station Serial # (SSN):	Session ID:(A,B,C etc)

NAD83 Latitude o ' "	NAD83 Longitude o ' "	NAD83 Ellipsoidal Height meters	Agency Full Name: David Evans and Associate, Inc.
Observation Session Times (UTC): Sched. Start ________ Stop ________ Actual Start 19:45 Stop 19:49	Epoch Interval= 1 Seconds Elevation Mask = 10 Degrees	NAVD88 Orthometric Ht. meters GEOID99 Geoid Height meters	Operator Full Name: David T. Moehl Phone #: ( ) (360) 314-3200 e-mail address: dtm@deainc.com

Receiver Brand & Model: Trimble SPS985
P/N: 82500-60
S/N: 5616F59510
Firmware Version: 5.30
❒ CamCorder Battery, ❒ 12V DC, ❒ 110V AC, ✓ Other

Antenna Code*, Brand & Model: Trimble SPS985 Internal
P/N:
S/N:
Cable Length, meters: n/a
Vehicle is Parked n/a meters ____(direction) from antenna.

Antenna plumb before session?	(Y / N) ✓	Circle Yes or No -If no, explain "
Antenna plumb after session?	(Y / N) ✓	
Antenna oriented to true North?	(Y / N) ✓	
Weather observed at antenna ht.	(Y / N) ✓	
Antenna ground plane used?	(Y / N) ✓	
Antenna radome used?	(Y / N) ✓	If yes, describe. Use Vis. form
Eccentric occupation (>0.5 mm)?	(Y / N) ✓	
Any obstructions above 10°?	(Y / N) ✓	
Radio interference source nearby	(Y / N) ✓	

Tripod or Antenna Mount: Check one:
✓ Fixed-Leg Tripod, ❒ Collapsible-leg tripod ❒ Fixed Mount
Brand & Model: Seco fixed height
P/N:
S/N: 5115-00-FLY
Last Adjustment date: 2018-03-05

Psychrometer (if used) Brand & Model:
P/N:
S/N:
Last Calibration or check Date:

** ANTENNA HEIGHT **	Before Session Begins: Meters	Feet	After Session Ends: Meters	Feet
A= Datum point to Top of Tripod (Tripod Height)	2.000		2.000	
B=Additional offset to ARP if any (Tribrach/Spacer)	0.000		0.000	
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)	2.000	6.56	2.000	6.56

Meters = Feet x (0.3048)
Height Entered Into Receiver = 2.000 meters.
Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model:
S/N:

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Celsius	WetBulb Temp Fahrenheit	Celsius	Rel. % Humidity	Atm. Pressure inches Hg	millibar
Before	00010	19:45							
Middle									
After	00010	19:49							

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Reference point is 0.2 feet SE of the SE side of a 1-1/2 foot steel pile. This is the furthest SE pile at the end of the Fred Devine Diving and Salvage Company dock in the Swan Island Lagoon. This pile is to be used for daily position checks for sediment sampling operations. Pile is for position only and not elevation.
NAD83(2011) Oregon North Zone International Feet Coordinates
North 700967.9 East 7634507.7

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s):
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

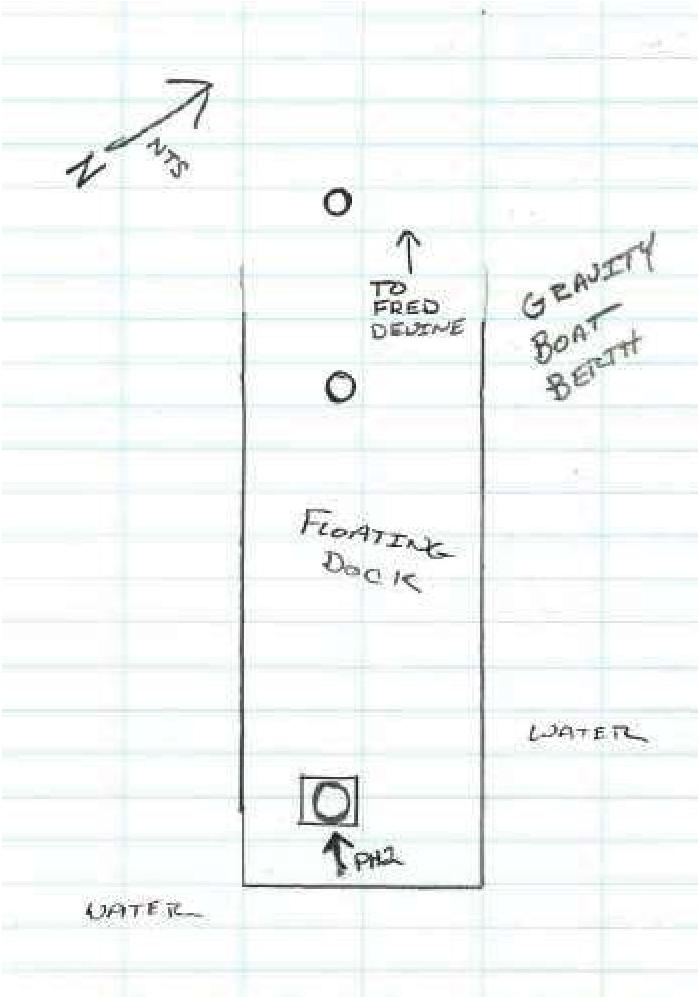
Updated Station Description:	❒ Attached	❒ Submitted earlier
Visibility Obstruction Form:	❒ Attached	❒ Submitted earlier
Photographs of Station:	✓ Attached	❒ Submitted earlier
Pencil Rubbing of Mark:	❒ Attached	

LOG CHECKED BY: Jon Dasler

Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)

Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind

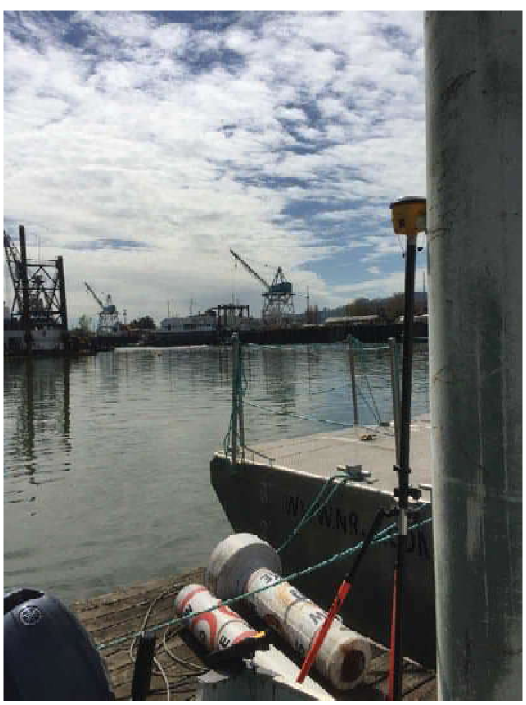
Sketch and Fieldnotes



200	CHK PH1		
	KNOWN COORDS	OBS	Δ (FT)
	N = 698702.46	N = 698702.45	0.01
	E = 7637426.37	E = 7637426.39	0.02
	Z = 33.38	Z = 33.37	0.01
201	SE FACE OF PILE		
	3-MIN OBS		
	N = 700967.87		
	E = 7634507.67		
	Z = N/A		
202	SW FACE	TOPO	
203	NW FACE	TOPO	
204	NE FACE	TOPO	

Overview of PH2 Pile

GNSS Setup on PH2 Pile



View facing south

View facing northwest

NOTE: This form intended for field use. Unsolicited data submitted to NGS must be converted to bluebook format.

GPS STATION OBSERVATION LOG
April 16, 2003

Station Designation: (check applicable:__ FBN__ CBN__ PAC__ SAC __BM) Raindeer		Station PID, if any:	Date (UTC): 06-Mar-18
General Location: Sauvie Island, Willamette River	Airport ID, if any:	Station 4-Character ID:	Day of Year: 065
Project Name: Portland Harbor - AETR00000034	Project Number: GPS-	Station Serial # (SSN):	Session ID:(A,B,C etc)

NAD83 Latitude ° ' "

NAD83 Longitude ° ' "

NAD83 Ellipsoidal Height meters

NAVD88 Orthometric Ht. meters

GEOID99 Geoid Height meters

Agency Full Name: David Evans and Associates, Inc.

Operator Full Name: David T. Moehl

Phone #: ( ) (360) 314-3200

e-mail address: dtm@deainc.com

Observation Session Times (UTC):
Sched. Start ________ Stop ________
Actual Start 17:38 Stop 23:45

Epoch Interval= 1 Seconds
Elevation Mask = 10 Degrees

Receiver Brand & Model: Trimble SPS855
P/N: 69855-60
S/N: 5506R0074
Firmware Version: 5.30
❒ CamCorder Battery, ✓ 12V DC, ❒ 110V AC, ❒ Other

Antenna Code*, Brand & Model: Trimble Zephyr 3 Base
P/N: 115000-00
S/N: 1551129193
Cable Length, meters: 10
Vehicle is Parked n/a meters ____(direction) from antenna.

Antenna plumb before session?	(✓/ N)	Circle Yes or No -If no, explain
Antenna plumb after session?	(✓/ N)	
Antenna oriented to true North?	(✓/ N)	
Weather observed at antenna ht.	(Y / N✓)	
Antenna ground plane used?	(Y / N✓)	"
Antenna radome used?	(Y / N✓)	If yes, describe. Use Vis. form
Eccentric occupation (>0.5 mm)?	(Y / N✓)	
Any obstructions above 10°?	(Y / N✓)	
Radio interference source nearby	(Y / N✓)	

Tripod or Antenna Mount: Check one:
✓ Fixed-Leg Tripod, ❒ Collapsible-leg tripod ❒ Fixed Mount
Brand & Model: Seco fixed height
P/N:
S/N: 5115-00-FLY
Last Adjustment date: 2018-03-05

Psychrometer (if used) Brand & Model:
P/N:
S/N:
Last Calibration or check Date:

** ANTENNA HEIGHT **	Before Session Begins: Meters	Feet	After Session Ends: Meters	Feet
A= Datum point to Top of Tripod (Tripod Height)	2.000		2.000	
B=Additional offset to ARP if any (Tribrach/Spacer)	-0.003		-0.003	
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)	1.997	6.55	1.997	6.55

Meters = Feet x (0.3048)
Height Entered Into Receiver = 2.000 meters.

Note &/or sketch **ANY** unusual conditions. Be **Very Explicit** as to where and how Measured!

Barometer (if used) Brand & Model:
S/N:

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Dry-Bulb Temp Celsius	WetBulb Temp Fahrenheit	WetBulb Temp Celsius	Rel. % Humidity	Atm. Pressure inches Hg	Atm. Pressure millibar
Before	00000	17:38							
Middle									
After	00000	23:45							

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s): 00740650.T02
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

Updated Station Description: ❒ Attached ❒ Submitted earlier
Visibility Obstruction Form: ❒ Attached ❒ Submitted earlier
Photographs of Station: ✓ Attached ❒ Submitted earlier
Pencil Rubbing of Mark: ❒ Attached

LOG CHECKED BY: Jon Dasler

Table of Weather Codes	CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
	0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)
	1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
	2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)

Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind

Photo of Monument RAINDEER

Photo of Monument RAINDEER

GNSS Setup on RAINDEER

APPENDIX B

FIELD SAMPLING FORMS

1. Daily Equipment Calibration Log
2. Waste Tracking Log
3. Bank Erosion Hazard Index
4. Physical Shoreline Inspection Form
5. Near-Bank Stress Risk

(Individual SOPs also include forms to be used, which are not listed here.)

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HGL HydroGeoLogic, Inc

Daily Equipment Calibration Log

Project Name: ____________________

Project Number: ____________________

Date	Time	Calibrated by	Instrument Make/Model/Serial Number	Standard/Manufacturer/Lots	Calibration Solution or Gas Concentration	Instrument Readings		Comments
						Before Calibration	After Calibration	

Waste Tracking Log

Project Name\Site:	
Project No:	
Waste Characterization Sample No(s):	
Waste Characterization Sample Analyses:	
Container/Date Sampled:	
PO Number:	

Container Type	Date Delivered	Container Designation/Location	Accumulation Date	IDW Source Locations	Media/Amount	Comments/Notes

Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

Bank Erosion Hazard Index (BEHI)

Stream:	Location:	
Station:	Observers:	
Date:	Stream Type:	Valley Type:

BEHI Score (Fig. 3-7)

Study Bank Height to Bankfull Height (C)

Study Bank Height (ft) =	**(A)**	**Bankfull Height** (ft) =	**(B)**	(**A**) / (**B**) =	**(C)**	

Root Depth to Study Bank Height (E)

Root Depth (ft) =	**(D)**	**Study Bank Height** (ft) =	**(A)**	(**D**) / (**A**) =	**(E)**	

Weighted Root Density (G)

Root Density as **%** =	**(F)**	(**F**) x (**E**) =	**(G)**	

Bank Angle (H)

Bank Angle as *Degrees* =	**(H)**	

Surface Protection (I)

Surface Protection as **%** =	**(I)**	

Bank Material Adjustment:

- **Bedrock** (Overall *Very Low* BEHI)
- **Boulders** (Overall *Low* BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment unless primarily clay, then subtract 20 points)

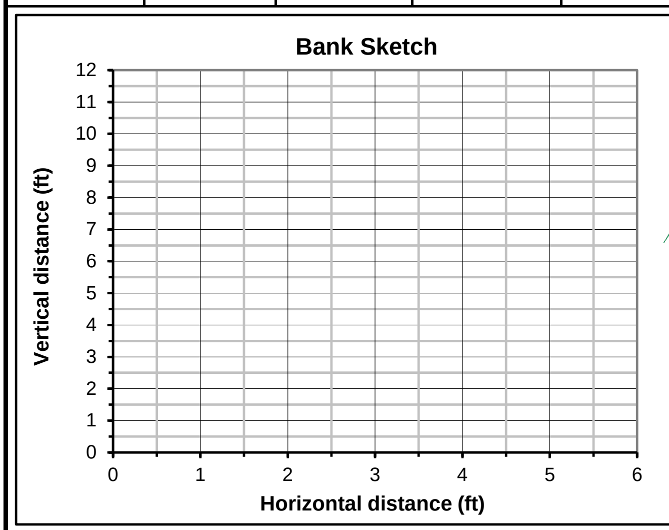
Bank Material Adjustment

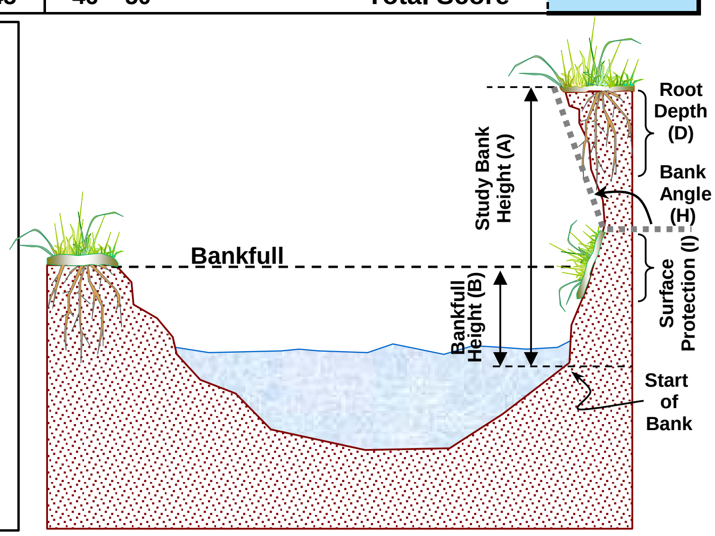
Stratification Adjustment

Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**





Physical Shoreline Inspection Form
SIB Project Area, Portland Harbor Superfund Site

This field form was developed from the *Guidance for River Bank Characterizations and Evaluations at the Portland Harbor Superfund Site* (USEPA, 2019) (Guidance). An assessment using this form must be completed for each geomorphic area or segment of the river bank with different physical and material characteristics because of the unique potential for erodibility each segment possesses. For further detail regarding Physical Shoreline Inspection requirements, please refer to Section 2.3 of the Guidance. As needed, information to complete this form may need to be obtained from topographic or bathymetric surveys or from available online reference for Portland Harbor, such as USGS gauging stations.

Prepared by: ____________________________ Date: ____________________________

Reviewed by: ____________________________ Date: ____________________________

River Mile Segment:	
Use of river bank segment:	
Bank Angle:	
Alignment of the River:	
Width and Depth of the River:	
Stream Velocity and Stage:	
Wind- and Boat-Induced Waves?	

River Bank Surface Protection:

Type of Surface Protection (woody debris, rooted vegetation, embedded boulders, revetment, bedrock, etc.):	% of Bank Covered by Surface Protection	Location of protection relative to the toe of the slop, top of the bank, and OHW elevation

Type and Size of Armoring (riprap, rock, gravel, concrete, gabions, retaining walls, etc.):	% of Bank Covered by Armoring	Condition of armoring (stable, unstable, sloughing into river, etc.)	Location of armoring relative to the toe of the slop, top of the bank, and OHW elevation

Physical Shoreline Inspection Form
SIB Project Area, Portland Harbor Superfund Site

River Bank Vegetation Type:	% of Bank Covered by Vegetation	Root Depth (depth relative to bank height in %):	Root Density (% of bank surface covered by roots):

River Bank Soil Types classified using the Unified Soil Classification System determined by ASTM D2488:		
Bedrock %:	Cobble %:	Sand or mostly sand %:
Boulders %:	Gravel or mostly gravel %:	Silt or clay %:

Bank stratification (circle one):	No layers	Single layer of erodible material	Multiple layers of erodible material

Visible indicators of active river bank erosion due to overland flow, wave and/or vessel wake, or other factors? Describe and document via photograph and GPS coordinates when possible.	
Evidence of previous river bank SCMs. Describe current integrity in providing protection against erosion.	

Presence of Aquatic Vegetation?	Yes	No

GPS points collected within tenth of RM:

Location ID	Description of point:	Photo Taken (Y/N)?

Additional Notes/Observations:

Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate an erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar, or central bar creating NBS	Level I	Reconaissance
(2)	Radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General Prediction
(3)	Pool slope to average water surface slope (S_p / S)	Level II	General Prediction
(4)	Pool slope to riffle slope (S_p / S_{rif})	Level II	General Prediction
(5)	Near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed Prediction
(6)	Near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed Prediction
(7)	Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)
- Transverse or central bars - short or discontinuous……...………… …………….....…**NBS = *High* / *Very High***
- Extensive deposition (continuous, cross-channel)………………..………………...……… ..…………...**NBS = *Extreme***
- Chute cutoffs, down-valley meander migration, converging flow…………………… …………...**NBS = *Extreme***

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	**Near-Bank Stress (NBS)**
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	**Near-Bank Stress (NBS)**
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	**Near-Bank Stress (NBS)**
(4)				

Dominant Near-Bank Stress

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	**Near-Bank Stress (NBS)**
(5)				

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	*Ratio* τ_{nb} / τ_{bkf}	**Near-Bank Stress (NBS)**
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	**Near-Bank Stress (NBS)**
(7)		

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) Ratings	**Method Number**						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) Rating	